FIGS. 1 TO 6. ROAD BUILDING UNDER AMERICAN ENGINEERS IN THE PHILIPPINES

Fig. 1—Typical native Filipino laborer. Fig. 2—Taking shelter from a blast. Fig. 3—Breaking stone for macadam surfacing Figs. 4 and 5—Grading operations. Fig. 6—Moving earth on short "hauls"

(Reproduced by courtesy of the Standard Oil Co. of California from the company's monthly "Bulletin")

Engineering Literature

"Consistency" of Physicists and Engineers

Sir—The review of Professor Goodenough's excellent little book of steam tables [printed in this issue] has stimulated the reviewer to record here some thoughts brought out by a study of the book—though not intimately connected with a discussion of the merits of the book itself.

As stated in the review, Professor Goodenough considers his tables more rigorously consistent than earlier ones, and he defines "consistent" tabular values as being those "obtained from equations that are properly connected by the necessary thermodynamic relations, such as the Clausius and Clapeyron relations."

If we have any sort of an equation such that values computed from it are in agreement with the data from trustworthy experiments covering a wide range of conditions, all values computed from it will be consistent, whether the equation is connected up with recognized thermodynamic relations or not. Consistency is merely following a fixed law, no matter how eccentric or seemingly unreasonable that law may be.

If the results of one or two isolated experiments are not in agreement with the computed values, we suspect the reliability of these particular experiments solely because they do not appear to be consistent.

The author's equation for the relation between the temperature and pressure of saturated steam is not visibly connected with any recognized thermodynamic relation. In fact it is strictly empirical, in the sense that it was made to fit observed data rather than a theory. On this account, however, the author would hardly be willing to admit that the tabular results computed from it are not consistent.

Granting that the Clapeyron equation represents a purely thermodynamic relation, the computation of actual values from it demands that we use values for various pressures which are computed from an empirical formula. Connecting up the Clapeyron equation with one that is strictly empirical would undoubtedly contaminate its alleged thermodynamic purity.

Thermodynamic theory has to be badly strained to make it fit the eccentric behavior of saturated steam. The relation between temperature, pressure and volume is most obscure. Isothermal expansion at constant pressure is difficult to understand. The marked difference between the work of adiabatic expansion and compression is puzzling. More disquieting than anything else is the uncanny intelligence of the heat, which enables it to retire as internal work during the early stages of an adiabatic expansion, and later on to come out and be converted into external work.

These remarks illustrate a continually outcropping difference between the physicist's and the engineer's efforts—a difference which needs to be emphasized every little while so that the engineer may be warned against striving for an impossible accuracy or an artificial "consistency" in his essentially practical operations.

H. E. Longwell.

New Haven, Conn., Dec. 23, 1915.

REVIEWS AND NOTES

Rainfall, Crops and Pig Iron

Reviewed by Allen Hazen*

ECONOMIC CYCLES: THEIR LAW AND CAUSE—By Henry Ludwell Moore, Professor of Political Economy in Columbia University. New York: The Macmillan Co. Cloth; 6x9 in.; pp. viii + 149; 27 illustrations. $2.

In Joseph's time there were seven fat years in Egypt, and these were followed by seven lean years. The fluctuations in the market and the profits that grew out of knowledge of these conditions are duly recorded. In the United States, in the last 70 years, according to the author of this book, there have been fat years and lean years that have succeeded each other in groups with considerable regularity, and these are associated with and grow out of variations in the rainfall.

The author applies a mathematical analysis to certain rainfall data. The average rainfalls recorded by the United States Weather Bureau for Marietta, Portsmouth and Cincinnati, Ohio, are used. These were selected because of their long records and proximity to the regions where most of the grain in the United States is raised. The cycles in the annual rainfall are ascertained by a mathematical analysis which the ordinary reader will find it difficult to follow. The result is none the less interesting. The author finds by its use that there are two cycles, one with a period of about 8 years and one with a period of about 33 years, and the combination of these two cycles produces a curve something like that produced by the combined effect of the ordinary tides and the neap and spring tides.

In the following chapters the relation between the size of crops and the amount of rainfall is developed, and this is followed by a study of the effect of the size of the crop upon the demand and the prices at which crops were sold, as shown by certain Government records. Finally the cycles in the production of pig iron are studied in the same way and are found to follow the rainfall records, but with a lag of several years. The explanation offered by the author is that the production of pig iron increases with the prosperity of the country, and that in turn depends upon the size and prices of the crops, and these depend upon the rainfall. The last chapter sums up the whole argument in plain language and enables one to get a rapid glance at everything which the author has attempted to prove.

The method of looking for cycles and demonstrating them seems worthy of wide application. Not everyone

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will be able to manage the mathematics. It is to be hoped that the author or someone else will follow the matter to see if the cycles in rainfall in all parts of this country and in other countries are the same as those found in Ohio.

In the last few years records of precipitation and runoff have been accumulating at an increasing rate. These data afford great opportunities for increased use in making possible a more complete utilization of natural resources. The methods of harnessing these data so as to make them effectively available have developed slowly and have not kept pace with the increasing supply of statistics. This book indicates a method of utilizing data of this kind that is worthy of the highest commendation.

Theory of Structures Revised

REVIEWED BY EDWARD C. SHERMAN*

THE THEORY OF STRUCTURES—By Charles M. Spofford, M. Am. Soc. C. E., Hayward Professor of Civil Engineering at the Massachusetts Institute of Technology. Second edition, revised and enlarged. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xv + 483; 350 text illustrations and drawings. $4, net.

The present edition includes the subject matter of the first edition (1911), revised, corrected and amplified after personal use by the author for four years with his classes at the Massachusetts Institute of Technology. The additions (77 pages, net) include an extension of the treatment of swingbridges, and chapters on the Theorem of Least Work, Earth Pressure, Masonry Dams and Masonry Arches.[1]

These new chapters form a valuable addition to the literature of structural engineering. All of the theories presented are illustrated by simple numerical examples in which the applications of the principles are clearly shown, and numerous problems for solution are also included.

In the new chapter on the Method of Least Work, the author shows the application of the theorem to various cases and by it develops equations for reactions in continuous trusses and for stresses in the redundant members of statically indeterminate structures. The simplicity of this treatment as compared with methods based upon deflections is of special interest to the reader who is unfamiliar with the theorem of least work, and this short chapter of only 13 pages is sufficient to give an engineering student possessing some knowledge of calculus an excellent understanding of modern methods of solving indeterminate structures. It is the most concise and clear treatment of this important subject which the reviewer has seen.

The chapter upon Masonry Dams deals entirely with the application of the principles of equilibrium to gravity dams. Due consideration is given to upward water pressure, and computations illustrating its effects upon a dam are included.

The chapter on Earth Pressure, consisting of nine pages, gives in excellent form the commonly used methods of treating this complicated subject.

Probably the most noteworthy addition to the book is the chapter on Masonry Arches with Fixed Ends, in which the author has developed the method first suggested by Müller-Breslau, in 1884, in which the original equations are referred to coördinates or axes of reference so located that one is an axis of symmetry and the other lies between the crown and the springing line at such an elevation as to eliminate certain of the terms which appear when the equations are referred to a horizontal axis passing through the springing line. The necessary equations are developed by the Theorem of Least Work by means of a simple treatment covering only a little more than a page. A particularly interesting portion of this chapter is that in which the relation between an arch and a fixed-end beam is shown. The author tests his arch equations by applying them to the extreme case of an arch with a radius equal to infinity, in other words a fixed-end beam, and finds that the results agree exactly with those obtained by the ordinary formulas for such beams.

An interesting feature of the book is the obvious avoidance of higher mathematics, the reader finding it necessary to be familiar with anything higher than algebra in only a few places. Where the calculus has been used the resulting methods are illustrated so clearly by numerical examples as to enable their ready application by those who are entirely ignorant of this branch of mathematics.

The older parts of the book, no less than the new, show that great care and thoughtfulness have been given to them. Indeed it may be said that the book gives a most concise, thorough and simple presentation of the principles underlying the design of engineering structures.

Practical Railway Engineering

RAILWAY MAINTENANCE ENGINEERING, with Notes on Construction—By William H. Sellew, M. Am. Soc. M. E., author of "Steel Rails, Their History, Properties, Strength and Manufacture." New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. xix + 360; 194 illustrations, 6 folding plates. $2.50, net.

The author states that this book has been prepared from notes used in his classes in railway engineering, but that matter of an advanced character has been introduced to make the book of value outside the classroom. Its value in the latter respect, however, would be greater if more space had been devoted to the work and methods of maintenance. A useful feature is a bibliography at the end of each chapter.

The first 70 pages are of a general character and deal with engineering, grading, bridges and culverts. The chapter on land is of particular interest as showing the methods of describing land to be acquired for railway purposes. Track materials and appurtenances cover about 155 pages. This section includes the deflection of roadbed under trains, the distribution of pressure by ballast, and brief notes as to track work. Buildings, and water and fuel stations are given 86 pages and signaling 38 pages.

The author points out that the young engineer is likely to be more concerned with the improvement of existing lines than the laying out of new railways. But the book contains nothing on such important classes of improvement work as double tracking, widening roadbed, reducing grades and curvature, track elevation, etc. Nor is there much in regard to track work or the organization of maintenance forces. In fact, the book deals with materials rather than with methods or work.

At some points a little more discrimination would have improved the book. Thus under ties, steel longitudinals, and steel, wood and concrete crossties are discussed, but no indication is given of the relative extent

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[1]The first edition was reviewed in "Engineering News" of Nov. 16, 1911, page 44 of separately paged "Engineering Literature" section.

or importance of these. Again yards and terminals are disposed of very briefly, while no less than 27 pages are devoted to icing stations. The book is rather heavy for its size. It is well printed and illustrated. The advisability of noting the names of makers of various devices seems doubtful.

Searles and Ives' Handbook

REVIEWED BY HENRY J. SAUNDERS*

FIELD ENGINEERING: A Handbook of the Theory and Practice of Railway Surveying, Location and Construction —By William H. Searles, M. Am. Soc. C. E. 17th edition, revised and enlarged by William H. Searles and Howard Chapin Ives, Professor of Railroad Engineering in the Worcester Polytechnic Institute. New York: John Wiley & Sons. Flexible leather; 4x7 in. Vol. I, text; pp. xvii + 309; 148 illustrations. Vol. II, tables; pp. vi + 323. Bound in one volume, $3, net; bound separately, $2, net, each.

This is the seventeenth edition, revised and enlarged with the assistance of Professor Ives, of one of the best-known field books used by engineers on railroad work. The changes made are general and include much information new to this edition. The work as a whole is brought up to date by the omission of certain parts and the revision of others.

Chapter II, covering the organization of engineering corps, has been brought up to date. It would seem, however, that the method of making preliminary surveys by transit and stadia might have been touched upon. Chapter III, dealing with railroad economics, has been revised and rewritten. The matter is handled in a very able manner as far as the space will permit. Chapters V, VII and VIII, dealing with the field work of running curves, and laying out turnouts, has been enlarged and gives a number of new methods. A short discussion of metric curves is given. Chapter IX is new and treats of the spiral, the text being descriptive of the original Searles spiral formerly given in a separate volume. This form of spiral is favored by a great many engineers, although in practice it is found that nearly all large roads have their own so-called "standard spiral."

Chapter XII describes the calculation of earthwork, one additional method being given and a paragraph being inserted on valuation work. Reference is made to the use of the equation $A = \frac{1}{2} bk + nk$ for the calculation of sections where the ground slopes uniformly between slope stakes. A slight variation of this formula is actually used on valuation work, that is, $A = \frac{1}{2} (mk + nh)$, which is as simple as the one recommended and does not require a uniform width of roadbed. The remainder of the chapter has been rewritten as regards prismoidal corrections, borrow pits, vertical prisms and a method by unit areas. Chapter XIII deals with the use of the very effective table of triangular prisms. This method is certainly gaining in favor, and its use should be more widely adopted. Chapter XIV describes earthwork diagrams, which are probably more convenient to use than tables on some work. For any great accuracy the diagram of cubic yards for 50 ft. for triangular prisms requires a sheet 16x20 in. for the first 10 ft. of height, but the writer has used one of this size on valuation work to good advantage.

Chapter XV is new and deals with haul and the mass diagram. The laborious arithmetical method is first explained, after which quite a well-written description of the mass-diagram method is given. The authors have committed the usual sin of omission by neglecting to distinguish fully between the mathematical operations involved in the determination of overhaul and the determination of the actual amounts due the contractor. This omission is emphasized by the fact that the matter of swell of material hauled is not taken up in the text. Volume I ends with Chapter XIX and several earthwork diagrams, the last chapters being taken from the original edition with few revisions.

Volume II consists entirely of tables and is very much enlarged. The tables of "Metric Curves," "Acres for Right-of-Way 100 Ft. Wide" and "Velocity Heads for Various Speeds" are new and will be appreciated by engineers engaged on the special kinds of work where they can be used. A table showing mean refractions in declinations, as given in Gurley's "Manual," is inserted.

Table XXXI, giving the triangular prisms described in Chapter XIII of the text, is new. The writer believes a more effective table for general use can be made by carrying the numbers in the left vertical column from 1 to 6.0 on one page and 6.1 to 12.0 on the next, and so on, running the horizontal numbers from 1 to 9 on the first and second pages, 10 to 18 on the third and fourth pages, and so on. The table need not occupy a greater space and could be used on ordinary work with a less number of operations. The tables necessary for the use of the Searles spiral have been rearranged and are given in this volume in full for chord lengths of 10 to 50 ft.

The writer believes that the additions which have been made to this work, although more along special than general lines, have made the book as a whole more valuable to engineers. The revisions are certainly progressive and in the right direction. The size of the two volumes when bound together is not enough larger than the old book to make any burdensome difference. The idea of having the book in two volumes, if desired, will undoubtedly appeal to some.

To sum up, the work as it now stands is a valuable addition to engineering reference books.

Belated Railway Statistics

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR 1914—27th Annual Report. Washington, D. C.: Division of Statistics, Interstate Commerce Commission. Cloth; 9x12 in.; pp. 785.

It is doubtful whether there is more accurate or thorough statistical work done anywhere in the Government service than by the Statistical Bureau of the Interstate Commerce Commission. The one severe criticism that must be made is that these statistics are not published until nine-tenths of their usefulness has passed. The present volume, published at the beginning of 1916 (although dated 1915), may be fairly assumed to represent the average conditions in the middle of the fiscal year which it covers, or on Jan. 1, 1914; but for most of the purposes for which statistics are used, one desires knowledge of present conditions and not conditions of two years ago. A few students of economics may at some time have occasion to delve into the past statistical history of railway companies; but not many practical men care about what happened two years ago.

For example there is likely to come up for settlement soon the most extensive and imperative demand for an increase in wages ever made by the railway employees of the United States. The question as to the grant of such an increase in wages is closely connected with ques-

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tions as to the profits the railway companies are earning, but it will be of little use to quote statistics about what was happening two or three or four years ago in view of the enormous change in rates and in volume of traffic that has taken place since that time.

It is fair to say that certain statistical results are given much earlier publication by the Interstate Commerce Commission. The reason which would doubtless be assigned for the long delay in publishing this volume is the length of time required to select and tabulate the vast mass of statistics it contains. It may well be asked, however, whether the public would not be far better served if the mass of these statistics were cut down to a small percentage of their present volume, so they could be published within not more than three or four months after the end of the year which they cover, instead of being delayed for eighteen months.

Industrial-Works Management

REVIEWED BY ROSSITER R. POTTER*

THE SCIENCE AND PRACTICE OF MANAGEMENT—By A. Hamilton Church. [Works Management Library.] New York: The Engineering Magazine Co. Cloth; 5x8 in.; pp. xviii + 535; illustrated by charts. $2.

Much of the literature of scientific management is written by men of more or less experience as managers or as efficiency experts. Usually, perhaps, the author really has valuable information to impart derived from his experience. Too frequently he sees fit to spread out his report on his own experience over a thin web of individual theorizing on the Pilate-like question, "What is scientific management?" always including the inevitable creed of principles. Truly notable progress has been and is being made in the general application of analytical methods, of the same type necessary in the work of the engineer, to the problems of industrial management. This movement has been obscured and marred by loose talk about principles and scientific management.

The title of Mr. Church's book seems to intimate that in his opinion scientific management has not yet been attained in practice. As a matter of fact he ventures to declare that the science of management has not yet even been expounded, for he describes his book as an attempt to formulate such a statement of fundamental facts and regulative principles as may be hereafter developed into a true science of management.

Mr. Church develops the idea that in every manufacturing organization there exist the same organic functions to be performed, each devoted to a special purpose; and that successful management consists of the correct comprehension, or analysis, and correlation, or synthesis, of these functions. He distinguishes five separate functions in the manufacturing organization—design, equipment, control, comparison and operation. These functions, he explains, call for and are performed through five different varieties of human effort. The economical regulation of effort he defines as one of the three regulative principles of manufacturing. The other two principles are the systematic accumulation and use of experience and the promotion of personal effectiveness. Some of the points covered by other writers in their lists of principles are included by Mr. Church in a list of five fundamental "axioms of administration," which he states cannot themselves be regarded as principles, although they are not directly derivable from the three principles he enumerates.

This book will be found refreshingly different from the usual run of scientific-management literature. It approaches the subject with the purpose of a purely theoretical discussion, with no pet shop systems or devices to introduce. It appeals to the reviewer as approaching more nearly than anything previously published to a truly scientific general discussion of the problems of management.

INSTALLING EFFICIENCY METHODS—By C. E. Knoeppel. [Works Management Library.] New York: The Engineering Magazine, 140 Nassau St. Cloth; 7x10 in.; pp. viii + 258; 103 illustrations. $3.

Mr. Knoeppel has produced what may be described, in the language of the machine-shop standardizer, as a magnified instruction card for anyone essaying to introduce certain methods and systems into a going organization. He explains in detail the proper sequence of investigations and first steps for such an undertaking, with particular emphasis on the means for securing coöperation and for interfering as little as possible with the existing organization.

The methods or devices to be introduced include time study, a planning department for scheduling and controlling the progress of work through the shop, the bonus plan of wage payment, and a system of reports recording and comparing the results obtained. In the chapter on the bonus plan, the author recommends a new bonus scale similar to Emerson's but incorporating a sudden increment at 100% efficiency, with a purpose corresponding to that of Mr. Taylor's differential piece rate.

The book is consistently of a practical nature, with no attempt to lay down abstract principles. It gives evidence of much experience in the actual details of the work described. The author's style is clear and direct, and his method of presenting the subject is novel and interesting.

British Workshop Drawing

ENGINEERING WORKSHOP DRAWING: First Steps in Engineering Drawing—By Henry J. Spooner, M. Inst. Mech. E., A. M. Inst. C. E., Director and Professor of Mechanical and Civil Engineering, Polytechnic School of Engineering, Regent Street, London. New York: Longmans, Green & Co. Cardboard; 9x7 in.; pp. viii + 128; 618 text figures. 50c. net.

In view of the plethora of American books on elementary mechanical drawing, this British volume will presumably be in small demand in this country. It is a good book but has no particularly striking features nor merits to offset the one or two minor disadvantages, from an American viewpoint, resulting from the divergence of British and American practice.

German Shop Bookkeeping

DIE BETRIEBSBUCHFUEHRUNG EINER WERKZEUG-MASCHINEN-FABRIK PROBLEME UND LOESUNGEN—Von. Dr.-Ing. Manfred Seng. Berlin: Julius Springer. Cloth; 8x11 in.; pp. vi + 87; 3 text figures and 41 blank forms. 5 marks.

The author presents a system of bookkeeping and cost-keeping for a machine-tool factory "of medium size" making many different kinds of machines ranging in weight from 1,000 to 100,000 kg. The same general bookkeeping methods can of course be adapted to other lines of manufacture. A list, or index of accounts, show-

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ing incidentally a numbering system, is followed by explanations of the various accounts. Next there are examples of the printed forms used, with directions and discussion. The book is notable for its combination of completeness of detail with compactness and practicability.

Steam and Ammonia Tables

REVIEWED BY H. E. LONGWELL*

PROPERTIES OF STEAM AND AMMONIA—By G. A. Goodenough, Professor of Thermodynamics, University of Illinois. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 7x10 in.; pp. vii + 108; illustrated. $1.25, net.

One who undertakes the prodigious labor of computing a set of tables of the properties of steam—not to speak of other vapors—to be sold at the ridiculously low price demanded for publications of this sort, certainly cannot be suspected of being actuated by mercenary motives.

A more descriptive title for the book would be "Tables of the Properties of Steam and Ammonia," as the tables are the essential part. The 29 pages of text will not be of general interest except in so far as they describe the tables and diagrams and instruct one in the methods of using them. Men who use these tables accept them on faith just as they accept the tables of logarithms, trigonometrical functions, etc. The portion of the text that deals with the basic experimental data and the general theory on which the computations rest is necessarily so abstruse that it is intelligible only to the very small number of specialists in thermodynamics—of which the reviewer is not one. Indeed one might regard this part of the text as a defense prepared in advance, in case anyone should have the temerity to attack the accuracy of the work.

The author claims that these tables are more rigorously consistent than those which have preceded them, and being based on later and more refined experimental data, are more accurate.

The physicist's conception of accuracy is quite different from that of the engineer. Comparing Professor Goodenough's tables of the properties of saturated steam with another set that is used extensively, we find that between the temperatures of 100° and 400° F., the actual differences do not appear to exceed a very small fraction of 1 per cent. As far as the solution of practical problems is concerned, these differences are insignificant. This is especially the case if problems are to be solved by the aid of the Mollier diagram, as differences of this magnitude are too minute to be discernible on a diagram constructed to any ordinary scale.

This comparison is no reflection on the excellence of the tables. It is merely a suggestion that the author's reason for their goodness is not quite as good as the tables themselves. They are very comprehensive and in many respects most conveniently arranged.

In the saturated-steam tables, the pressures below atmospheric are given in parallel columns in pounds per square inch and inches of mercury. It is not unusual to find a table with the pressures given in pounds per square inch and the equivalent in inches of mercury, or one giving the pressures in inches of mercury with the equivalent in pounds per square inch. The combination of both in a single table is decidedly novel and commendable. In the extreme lower range, the pressure differences are as little as $\frac{1}{10}$ in. of mercury.

In the superheated-steam tables, actual temperatures are given instead of degrees of superheat. Ten-degree intervals are used up to about 200° of superheat, and 50 intervals beyond. The tabular values cover the volume, entropy and total energy. Table 4 gives the barometer readings corresponding to boiling points of water between 190° and 214° F., varying by tenths of a degree; also the temperatures corresponding to the boiling points at barometer readings between 20 and 31 in. of mercury, varying by 0.1 in. The table of the thermal properties of water presumably gives these comparatively small values with a higher degree of accuracy than those which have preceded it. Following this is an exhaustive table of the properties of mixtures of air and saturated water vapor, which is useful in solving problems relating to the humidifying of air and to cooling towers for condenser plants.

The tables of the properties of ammonia are very elaborate. With the pressure as the argument, the table for the saturated vapor covers the range between 1 lb. and 200 lb. The table using the temperature as the argument covers the range between minus 50° and 195°. There are also tables of the properties of superheated ammonia and the thermal properties of the liquid.

On the last page are conversion tables giving the numerical relations between the various units of pressure, energy and work. These tables are noteworthy in that they include not only the actual numerical values, but the corresponding logarithms as well. Mollier diagrams for steam and ammonia are inserted for the benefit of those who like that sort of thing.

In brief the author has produced an excellent book of thermal tables, convenient in arrangement and embodying the results of the latest and most refined experimental investigation.

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Public-Health Administration

A MANUAL FOR HEALTH OFFICERS—By J. Scott MacNutt, Lecturer on Public Health Service in the Massachusetts Institute of Technology; With a Foreword by William T. Sedgwick, Professor of Biology and Public Health, Massachusetts Institute of Technology. New York: John Wiley & Sons, Inc. Cloth; 5x8 in.; pp. x + 650; $3, net.

At last there has been written a handbook of moderate size, well designed and well executed to meet the needs of the uptodate American health officer.

After presenting a notably good review of the organization, powers and functions of local, state and Federal health authorities, and recognizing the valuable work being done by unofficial health organizations, the author devotes a chapter to "The New Public Health." He then presents the nature and means of control of the various communicable diseases, using some two hundred pages, or two-thirds of his space, for this purpose. There are then taken up, in succession, child hygiene, milk and other food supplies, housing and industrial hygiene, nuisances, sanitary law, the annual report, vital statistics and publicity. A number of appendixes present some of the subjects in further detail.

Emphasis is laid on the local governmental unit as the main reliance in public-health administration and on the infective individual, rather than infected inanimate objects, as the means of spreading communicable diseases. Particularly indicative of the author's viewpoint is the fact that while he has a chapter on "Water-Supplies"

there is no chapter on sewerage, but merely a section on disposal of excreta in the chapter on "Nuisances."

As might be expected, the merit of the book lies not so much in the new matter presented as in the method and spirit of presentation and the way in which the everyday needs of the health officer have been kept in mind. Part I, on the organization and powers of health authorities, is a distinctive contribution to health writings. Part II, on administrative work, is an achievement in condensation and adaptation of existing material to suit the needs of this work.

Subsequent editions might advantageously contain still more material on routine practice than does this one. This would seem to necessitate a choice between considerable enlargement and further condensation and an increase in the already numerous references to more extensive sources of information. The latter course seems the preferable one. It will become more and more feasible with the multiplication of public-health courses and schools and with the increase in the standard qualifications for health officers.

Finally, it would not seem fitting to close this notice without mentioning Prof. William T. Sedgwick, to whose teaching and inspiration not only this book but the whole of the new public-health movement owes so much.

Machine Design and Theory

REVIEWED BY JOHN G. D. MACK*

MACHINE DESIGN—By Albert W. Smith, Director of Sibley College, Cornell University, and Guido H. Marx, Professor of Machine Design, Leland Stanford Junior University. Fourth edition, revised and enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. xii + 500; 278 illustrations, 31 tables. $3 net.

The fourth edition of Smith and Marx's excellent treatise on machine design, which has been a standard work on the subject for the past ten years, is a real addition to technical literature. It has been thoroughly revised and much valuable material added from the results of investigations on machine elements.

A treatise of this character has two rather distinct uses—(1) as a textbook in engineering schools, and (2) as a reference book for the designer in professional practice. A book which is satisfactory for one of these purposes is not necessarily so for the other, and anyone who has practiced and taught machine design can readily name books particularly adapted to either one or the other of these fields. The former editions of Smith and Marx have been especially well balanced as meeting the needs of the engineering student and the machine designer, but this double purpose is met in even greater degree in the fourth edition.

The subject is presented under three heads: (1) Kinematics, (2) Mechanics, (3) Application of the Principles of (1) and (2) to the determination of the size and form of machine parts.

Throughout the book are many footnote references to the sources from which the data are obtained. They are of great value if one wishes to pursue any particular subject farther than the limits of such a work permit.

In the text are given many suggestions based on "commonsense" and experience—those two anchors on which the designer of machinery must never lose his hold, regardless of his knowledge, however thorough it may be, of mechanics, kinematics, stresses and materials.

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In the treatment of the design of the C-punch frame the straight-line formula alone is used. While it is still an unsettled question as to whether the curved-beam theory is necessary in the study of the cast-iron frame, it has a distinct value in the design of steel frames, and it appears that the curved-beam theory should be included.

Among many excellent discussions in this book the chapter on riveted joints and the condensed table of critical speed formulas for shafting may be mentioned.

While the subject of the testing of materials has had a most intense scientific development, the study of the strength, wear and other factors entering into the rational design of machine elements offers one of the greatest fields for scientific research—the field which has been worked less than any other in proportion to the available problems.

THE THEORY OF MACHINES—By Robert F. McKay, Lecturer in Theory of Machines and Machine Design at the City and Guilds (Engineering) College, London. New York: Longmans, Green & Co. Cloth; 6x9 in.; pp. viii + 440; 407 text illustrations. $4.20 net.

Mr. McKay's extensive work is an attempt to group the entire subject matter relating to the theory of machines in one volume, classified as follows: I, Mechanics; II, Kinematics of Machines; III, Dynamics of Machines. After the manner of most English textbooks, a large number (358) of problems are given, grouped by chapters. The presentation of a few typical problems, as is done in most American textbooks, is a more satisfactory method from our standpoint. If used as a textbook, the teacher should formulate his own problems, while if used as a reference book, the typical problem worked out in detail is more useful.

In the chapters on toothed gearing, the author has maintained the correct distinction between the terms "face" and "addendum," a confusion of which has been made by many American writers.

Outside of a chapter on "Balancing," this work offers but little not found in standard treatises.

Engineering for Farmers

PRACTICAL TALKS ON FARM ENGINEERING: A Simple Explanation of Many Everyday Problems in Farm Engineering and Farm Mechanics Written in a Readable Style for the Practical Engineer—By R. P. Clarkson, Professor of Engineering, Arcadia University, Nova Scotia; Consulting Engineer; Engineering Correspondent of the "Rural New-Yorker." Garden City, N. Y.: Doubleday, Page & Co. Cloth; 4x8 in.; pp. xv+223; 43 illustrations. $1, net.

These "talks" were originally contributed to numerous agricultural and other papers, chiefly as answers to "hundreds of questions" addressed to the *Rural New-Yorker*. The talks have all been "carefully revised and rewritten."

The main topics are buildings, water-supply and sewage disposal, power, drainage, irrigation, road building, "The Forms of Electricity." A dozen pages at the end of the book are filled with "Useful Tables for Engineering Calculation."

Naturally such a book is unbalanced in space and uneven in merit, giving more information on some subjects and less on others than the average farmer needs. On the whole the book deserves commendation. A slip was made in stating that overshot wheels are inefficient under normal conditions, and another in saying that the Pelton wheel is equal to the turbine under all heads above 25 ft. Ten per cent. for depreciation and repairs of farm tractors seems too low.

As is so common in books for popular consumption, the author gives a wrong conception of the septic tank, but he is less misleading than many in this regard. Disappointment will probably come to those who accept his estimate of $15 or $20 as the cost of the septic tank figured in the book. The $15 "includes the purchase of cement, sand and gravel, the lumber for forms, the tile for the drains, and a hundred feet of vitrified sewer tile for inlet pipe." The $5 extra is supposed to cover cases where "labor must be paid for."

Builders of the Panama Canal

HISTORY OF THE PANAMA CANAL: Its Construction and Builders—By Ira E. Bennett. Associate Editors: John Hays Hammond, Patrick J. Lennox, E. A. Litt, D., William Joseph Showalter, Capt. Philip Andrews, U. S. N., Rupert Hughes, M. D., D. P. H., J. Hampton Moore. Builders' Edition. Washington, D. C.: Historical Publishing Co. Cloth; 7x11 in.; pp. 583; illustrated. $5.

Of the numerous books which have been published on the Panama Canal, this has the distinction of being the most bulky volume, excepting of course the various official reports that have appeared. Of the 520 pages in the book, the first 113 are devoted to history proper, from the discovery of Panama to the undertaking of the canal work by the United States in 1901. The author then, instead of proceeding with the story of the building of the canal, inserts one chapter entitled "The Completed Canal" and another on "The Sanitary Department," after which he goes back to the beginning of the work. His chapter entitled "The Canal Under Wallace" contains four pages. The following chapter entitled "The Stevens Régime" is of the same length. Then comes a chapter of half a dozen pages entitled "The Coming of Goethals." Additional chapters discussing special features of the work make a total of about 60 pages devoted to the construction of the canal.

By this time the author had apparently written himself out, for he then inserted articles contributed by various distinguished writers, including John F. Wallace, T. P. Shonts, John F. Stevens, Theodore Roosevelt, A. F. MacArthur, Gen. Leonard Wood, John Hays Hammond and Sir Hiram Maxim. A great variety of subjects is treated in this section, as may be judged from the titles of a few of the chapters: "The Navy and the Panama Canal"; "Problems in Quarantine"; "Our Foreign Commerce"; "Bolivia and the Panama Canal."

The remaining chapters, occupying nearly half the book, have the following titles: "The Canal's First Effects on Trade, Ports and Transportation"; "American Industries and the Canal"; "Industrial Roll of Honor of the Panama Canal." In one of these chapters there appears a description of many of the materials, supplies and machines used in the construction of the canal, descending even to an extended eulogy of breakfast food of a certain well-advertised brand said to have been furnished to the canal workers. Two columns are devoted to a history of the firm which supplied the spoons with which the breakfast food was eaten. Under the heading "Railroad Developments" is inserted a long history of the Erie Railroad Co., in which we read that "in New York City the transatlantic and coastwise docks and the New York hotels, theater and shopping districts are convenient to the Erie R.R." Under "tourist accommodations" is found an account of various hotels in New York City, of one of which we read:

> It is the first and only hotel for the use of women exclusively. It contains 450 rooms, single and en suite, and is operated on the same plan as any other hotel, with the exception that men visitors are not permitted above the drawing-room floor.

This sort of bald advertising—to put it plainly—is unfortunately typical of this section of the book. It is unfortunate, because other parts of the book do contain a good deal of interesting and valuable matter. The author does not write his story in the systematic way that an engineer might have done, but he has a newspaperman's ability to write in a way that interests and holds the attention of the reader.

Especial praise is due the author for the numerous halftone views, which are printed on full plates and are admirably executed.

The Commission-Manager Plan

MUNICIPAL FREEDOM: A Study of the Commission Government—By Oswald Ryan, formerly of the Department of Government, Harvard University. With an Introduction by A. Lawrence Lowell, President of Harvard University. Garden City, N. Y.: Doubleday, Page & Co. [The American Books.] Cloth; 5x8 in.; pp. xvi + 233. 60c. net.

Engineers and other technically trained men employed by cities or desirous of seeing professional and municipal advancement should welcome this book. In small compass the author presents what is perhaps the most forceful, consistent and convincing argument for the commission-manager plan of city government that has yet appeared. That in itself may not appeal to all engineers, but they will appreciate the author's argument for expert, permanently retained officials in all branches of the city administrative service. That Mr. Ryan believes this ideal may best be secured by the commission-manager plan is certainly reason for giving attention to his whole thesis—even at the risk of becoming a convert to the main argument.

Aside from his fresh and forceful presentation of the commission-manager plan, the author's great contribution is his clear exposition of the fundamental weakness of the straight commission plan—the selection of the chief executive officers of a city by popular vote. The commission-manager plan restricts the commission or council to legislative or truly representative functions and provides a single "permanent" executive head. By this means democracy and efficiency are assured—a thing often despaired of. So the argument runs.

How a manager subject to instant discharge at the pleasure of a commission can be regarded as a "permanent" official, Mr. Ryan does not explain. In one place, and one only, he seems to hint that this is a dream that will come true when the wisdom of that plan is recognized by the electorate and by the council, as it seems to be in the case of the burgomaster in German cities.

The usefulness of the book is increased by an appendix containing some of the more notable commission and commission-manager charters and by a bibliography of fair length. An unpardonable sin of omission is the lack of an index.

Engineering Geology Revised

ENGINEERING GEOLOGY—By Heinrich Ries, Professor of Economic Geology in Cornell University, and Thomas L. Watson, Professor of Economic Geology in the University of Virginia and State Geologist of Virginia. Second edition, enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. xxvii + 722; 249 text illustrations and 101 plates. $4, net.

The second edition of this valuable engineering text and reference book has a new chapter on historical geology. The first edition, reviewed in *Engineering News*,

Sept. 17, 1914, is only a year old. Except to make typographical corrections and add more recent references to the bibliographies, no changes have been made in the original text. The authors state that the new chapter is added in response to numerous requests. It is a wise addition. The fundamentals of stratigraphical geology form not only one of the most interesting parts of the subject to the general reader, but often an important part for the civil engineer to know. In this book are 47 pages giving as concise and complete a summary of historical geology as is probably available to the average engineer.

Electric Railway Design

REVIEWED BY WILLIAM A. DEL MAR*

THE ELECTRIC RAILWAY—By A. Morris Buck, Assistant Professor of Railway Electrical Engineering, University of Illinois. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xi + 390; 193 illustrations. $3 net.

The purpose of this book is to present to advanced students a course on the underlying principles of electric-railway design and operation. The subjects discussed are general considerations, the mechanics of traction, tracks, rolling stock, signals, power stations, transmission, substations and distribution circuits. These subjects are treated in an elementary way, clearly and without neglecting the most recent practice. A good perspective is given to the descriptive parts of the work by brief outlines of historical development, which enable the student to better appreciate the reasons for existing practice. Mathematics is used where needed, especially in the consideration of the mechanics of train movement. A knowledge of the most elementary calculus is required to appreciate these parts, the author thereby securing a briefness and generality in his statements which is often missed where pains are taken to avoid this useful mathematical tool.

The book is not in any sense a reference or practical man's book, neither is it always authoritative in technical matters, although it is only fair to say that the few such features to which exception might be taken are not sufficiently important to mar the work. It is essentially a students' textbook, readable, clear and instructive.

Nearly one-fifth of the book is devoted to the mechanics of train movement, a proportion which many readers will consider excessive. It is also open to the criticism that it is written from the point of view of the designing engineer, slighting features of particular interest to the operating man. There is little or nothing on the economics of electric railways. Another noteworthy omission, to which the author alludes in the preface, is the subject of carhouses, for which the reader is referred to the recent electrical handbooks.

A better idea of the book may perhaps be obtained from a more detailed description of a typical chapter, say that on "Braking of Electric Trains." This chapter, 35 pages long, begins by telling the importance of braking from the point of view of rapid schedule and economy of energy, proceeds with a description of the various methods of retardation, discusses their theory—especially the theory of friction and the transmission of braking forces through cars; and the first half of the chapter ends with a theoretical discussion of rotational inertia. The second half of the chapter is devoted to descriptions of the various forms of brakes—hand, air, vacuum and magnetic. Other chapters have a similar and, in general, judicious mixture of general principles, theory and descriptive matter.

The practicing engineer, tied to a particular small field in his profession, will find this book useful to broaden his outlook and bring him up to date in his general knowledge of other fields. Others, more fortunate in being able to keep abreast of the times, will find it too elementary to be of much use to them.

*600 West 59th St., New York City.

Electrical Engineer's Handbook

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS—Prepared by a Staff of Specialists, Frank F. Fowle, M. Am. Inst. E. E., Editor-in-Chief. Fourth edition, rewritten and greatly enlarged. New York: McGraw-Hill Book Co. Leather; 4x7 in.; pp. 1,984; illustrated. $5 net.

The eight years' commercial success of this line of successive "Standard" electrical engineer's handbooks has dispelled the doubts which some engineers had once of the reception to be expected for a handbook built on the condensed-treatise plan. The enormous sales of the book have demonstrated the acceptability of the scheme. Reviewing the changes evident in the several editions which have now been issued, continual progress is shown toward maximum practicality, without sacrificing the broad presentation of theory which is intimately tied up with electrical design and operation. So little of the old editions is left in the latest one that the volume must be regarded as essentially new. It will be recalled that the publishers of this book originated the scheme, at least in this country, of a handbook in sections contributed by specialists. Much of the growth in practicality may be attributed to the much stronger staff of section authors of the present edition.

In a work of uniform general excellence, it is useless to comment on the worth of particular sections, but there are two outstanding features which must be commended—the indexes and the bibliographies. The combination of section, thumb and topical indexes fully exposes the contents with minimum delay and labor; if there should be any large deficiency of information for any specific reader, the bibliographies will lead him to it.

How the different subjects are handled may be gathered from the following brief comments—which, however, it should be noted, touch only some of the "high spots" of the book:

The section on electric and magnetic circuits is the only one entirely theoretical. "Electrical and Magnetic Measurements" is essentially practical—giving descriptions and data of apparatus and methods. "Thermal Measurements" practically all relates to high-temperature work. "Water, Gas, Air and Steam Meters" is wholly descriptive. "Materials," as might be expected, is largely devoted to the electrical properties of copper, aluminum, iron, steel and insulating materials, and to the magnetic properties of iron and steel.

"Magnets and Induction Coils" is largely theoretical, but gives empirical data for design. "Alternating-Current Generators and Motors" is opened up with descriptive matter, fundamental theory and empirical constants used in design. Operating reactions are described. There is a little on the mechanical design of alternating-current machinery. This section has a comprehensive collection of brief descriptive notes on the multitude of various alternating-current motors now available. "Direct-Cur-

rent Generators and Motors" starts off with theory and descriptive notes interjected. Design procedure is outlined and notes are given on practical operation and testing.

"Power Plants" is split into hydraulic and steam-, gas- and oil-engine stations. For fuel-burning plants there are descriptive notes on plant fixtures, apparatus and the phenomena involved. There are many data on current performance and the properties of local fuels. "Water-Power Plants" starts off with elementary hydraulics of flow. Stream-flow studies and the general design of dams are outlined. There are brief descriptions of turbines. Under "Electrical Equipment of Power Plants" are descriptive notes on excitation and voltage-control systems, direct- and alternating-current switching, station transformers and arresters and station wiring. A discussion of power-station economics shows the Stott methods of cost analysis.

"Illumination" is a comprehensive review of physical laws and phenomena, with discussions of the available incandescent and arc lamps, reflectors and shades. There is a very comprehensive section on industrial motor applications. Conditions favoring group or individual drives are tabulated, and horsepower requirements of a few hundred machine tools, wood-working machines, etc., are inserted.

"Power Transmission" has descriptions of systems and calculations for line design. Practical problems of construction—poles, steel towers, wire supports, insulators, cables, etc.—are presented. "Distribution Systems" outlines the field for alternating and direct currents, and current practice and design. Various mill machinery is briefly described with reference to the power demands of specific machines.

"Electric Railways" reviews the laws of train resistance and the use of speed-time and motor-characteristic curves to precast power requirements. Data are tabulated on physical characteristics of present motors; control and braking systems; typical trucks and car bodies; leading features of American locomotives, etc. Railway-signaling and switch-interlocking practice is described. Under "Electrolysis" the action of stray currents is portrayed, and prevention of trouble is described. General directions are included for electrolysis surveys, and useful data are tabulated. "Electric Vehicles" shows classification of commercial vehicles and the construction of chassis, transmission gear, etc. Car resistance and car requirements are discussed. Data are included on the features of prominent types. Service-cost comparisons are appended for horse, gasoline and electric vehicles. Electric ship propulsion is elevated to the dignity of a section in which fundamental dynamics of ship propulsion are outlined. Electric propulsion is treated as a form of gearing between engine and propellers.

It could hardly be expected that the book would be entirely beyond the range of criticism, but the minor nature of any adverse comments that may be made, is seen from the following review of some of the more evident points which have come to light in a few weeks' desk use of the book:

The condensation required to promote great breadth in the tables of units and conversion factors has resulted in the absence of an easily found statement of various foot-pound equivalents of horsepower, or square feet and square yards in an acre or a square mile. Under electrical and magnetic measurements the development of maximum demand meters is hardly up to date. Mechanical power measurements have been extremely abbreviated, consisting of 1½ pages on brake dynamometers, half a page on transmission dynamometers and half a page on speed measurements. The testing of synchronous alternating-current machinery is rather too briefly passed over and is out of balance with the corresponding section on testing of direct-current machinery. Under hydraulic power plants there is not much on impulse wheels. Under electro-chemistry there is hardly enough on alkali plants and nitrogen fixation. The section on telephony and telegraphy has nothing on radio-telephony.

Central-Heating Stations

DISTRICT HEATING: A Brief Exposition of the Development of District Heating and Its Position Among Public Utilities. By S. Morgan Bushnell, M. Am. Inst. E. E., Past President, National District Heating Association, and Fred B. Orr, Commercial Engineer, Illinois Maintenance Co. New York: Heating and Ventilating Magazine Co. Cloth; 6x9 in.; pp. ix + 290; 82 illustrations. $3 net.

Anyone who desires to investigate the possibilities of a central-station heating system should not neglect the reading of this volume, giving as it does the history of the art and industry, business methods employed in selling, layout and equipment of systems, house metering, station operation, estimating customers' requirements, etc.

Electrical-Engineering Text

ALTERNATING-CURRENT WORK: An Introductory Book for Engineers and Students—By W. Perren Maycock, M. Inst. E. E.; Consulting Electrical Engineer; late Technical Editor to the Westinghouse Companies' Publishing Department in Europe. An enlargement of and an improvement upon the author's former work, "The Alternating-Current Circuit and Motor." New York: The Macmillan Co. Cloth; 5x8 in.; pp. xxiii + 415; 258 illustrations. $2.25.

A book like this on elementary electrical engineering, designed for British students and showing British apparatus, has no chance for general adoption in the United States in competition with many equally good texts drawing on American practice for illustrative material. But any such good teaching notes are of interest and service to instructors in a foreign country. Elementary theory is presented with the liberal use of hydraulic and mechanical analogies. Theory is supplemented with a brief exposition of construction and use of a few important alternating-current machines.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN CERAMIC SOCIETY—Transactions of Meeting at Detroit, Mich., Feb. 15-18, 1915. Columbus, Ohio: Edward Orton, Jr., Secretary. Cloth; 6x9 in.; pp. 815; illustrated.

ANNUAL REPORT OF THE GOVERNOR OF PORTO RICO, 1915—Washington, D. C.: War Department. Paper; 6x9 in.; pp. 464.

Divisional reports deal with irrigation, sanitary engineering, roads and bridges, harbors and docks, communicable diseases and other subjects.

ANNUAL REPORT OF THE NEW JERSEY STATE BOARD OF HEALTH, 1914, and Report of the Bureau of Vital Statistics—Trenton, N. J. Cloth; 6x9 in.; pp. 527; illustrated.

ANNUAL REPORT OF THE (NEW YORK) STATE ENGINEER AND SURVEYOR, 1914—Albany, N. Y. Cloth; 6x9 in.; pp. 448; illustrated.

ANNUAL REPORT OF THE SUPERINTENDENT, UNITED STATES COAST AND GEODETIC SURVEY, 1915—Washington, D. C.: Division of Publications, Department of Commerce. Cloth; 6x9 in.; pp. 156; illustrated.

ANNUAL REPORT, MILWAUKEE (WIS.) BUREAU OF MUNICIPAL RESEARCH, 1914-15—Milwaukee: The Bureau. Paper; 6x9 in.; pp. 24.

THE ARCHITECTS' AND BUILDERS' POCKET-BOOK: A Handbook for Architects, Structural Engineers, Builders and Draughtsmen—By the late Frank E. Kidder, author of "Building Construction and Superintendence." Compiled by a staff of specialists, Thomas Nolan, Editor-in-chief, Professor of Architectural Construction, University of Pennsylvania. 16th edition, rewritten. New York: John Wiley & Sons. Flexible leather; 4x7 in.; pp. xxiii + 1,816; illustrated. $5 net.

ASH COLLECTION IN MILWAUKEE, 1914-15—Milwaukee, Wis.: Bureau of Municipal Research. Paper; 6x9 in.; pp. 45.

A detailed local survey, with diagnosis of ills and suggested remedies. Cost figures are given.

AUTOMOBILE REPAIRING MADE EASY: A Complete Treatise Explaining Approved Methods of Repairing All Parts of All Types of Gasoline Automobiles—By Victor W. Page, author of "The Modern Gasoline Automobile." New York: The Norman W. Henley Publishing Co. Cloth; 6x9 in.; pp. 1,060; 479 illustrations. $3 net.

BRITISH COLUMBIA HYDROGRAPHIC SURVEY FOR 1914—By R. G. Swan, Chief Engineer. Ottawa, Canada: Dominion Water Power Branch, Department of the Interior. Water Resources Paper 14. Paper; 7x10 in.; pp. 534; illustrated.

THE COLLECTION AND DISPOSAL OF CITY REFUSE—Ames, Iowa: Iowa State College of Agriculture and Mechanic Arts. Bulletin 15, Engineering Extension Department. Paper; 6x9 in.; pp. 36; illustrated.

A general review, with extracts from several engineering reports, followed by notes on the practice of a number of Iowa cities.

CONCRETE SILOS: Their Advantagees, Different Types and How to Build Them—By E. S. Hanson, Editor "Cement Era." Chicago: Cement Era Publishing Co. Cloth; 5x8 in.; pp. 174; illustrated. $1.

COMPENSATION LEGISLATION OF 1914 AND 1915—Washington, D. C.: U. S. Bureau of Labor Statistics. Bulletin 185. Paper; 6x9 in.; pp. 408.

Besides giving in full the new legislation in a dozen states, the statutes printed are summarized. A useful tabular summary is given of the compensation laws of 31 states and Alaska, Hawaii, the Canal Zone, the Philippines and the United States. The bulletin supplements Bulletin 126, "Workmen's Compensation Laws of the United States and Foreign Countries."

CITY PLANNING, With Special Reference to the Planning of Streets and Lots—By Charles Mulford Robinson, author of "Modern Civic Art," "The Improvement of Towns and Cities," etc. A reissue, revised, with much additional material, of the work originally published under the title of "The Width and Arrangement of Streets." New York: G. P. Putnam's Sons. Cloth; 6x9 in.; pp. xiv + 344; 58 illustrations. $2.50 net.

ENGINEERING AS A CAREER: A Series of Papers by Eminent Engineers—Edited by F. H. Newell, Professor of Civil Engineering, University of Illinois; Consulting Engineer, United States Reclamation Service; Director 1907-1914, Chief Engineer 1902-1907, and C. E. Drayer, Secretary Cleveland Engineering Society; Engineer, New York, Chicago & St. Louis Railroad Co. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. xii + 214. $1.

EXCESS CONDEMNATION—A Report of the Committee on Taxation of the City of New York, with a Report Prepared by Herbert S. Swan for the National Municipal League. New York (Municipal Building): The Committee. Paper; 7x10 in.; pp. 122; illustrated.

Some of the arguments for excess condemnation are given, together with a considerable amount of history, constitutional amendments and legislation making the practice possible. A New York statute of 1872 is an interesting and surprising feature.

HOW TO REDUCE WATER TAXES—THE INSPECTOR—By Jacob Klein, Chief Inspector of Complaints, Bureau of Water-Supply, Manhattan, City of New York. New York (50 Church St.): Water Conservation Co. Paper; 6x9 in., pp. 36.

A variety of notes on matters relating to the inspection of water meters and house fixtures, prepared from the general viewpoint of water-waste control.

ILLUMINATION FOR FARM AND TOWN HOMES—By Grayson B. McNair. Manhattan, Kan.: Kansas State Agricultural College. Bulletin 1, Engineering Experiment Station. Paper; 6x9 in.; pp. 15.

AN INTRODUCTION TO APPLIED MECHANICS—By Ewart S. Andrews, Lecturer in the Engineering Department of the Goldsmiths' College, New Cross, and of the Westminster Technical Institute. New York: G. P. Putnam's Sons. Cambridge, England: University Press. [Cambridge Technical Series.] Cloth; 6x9 in.; pp. ix + 316; 87 text illustrations. $1.10.

INVENTIONS AND PATENTS—By Philip E. Edelman, author of "Experimental Wireless Stations," etc. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. ix + 288. $1.50 net.

IRRIGATION IN THE UNITED STATES: A Discussion of Its Legal, Economic and Financial Aspects—By Ray Palmer Teele, Irrigation Economist, Office of Public Roads and Rural Engineering, United States Department of Agriculture. New York: D. Appleton & Co. Cloth; 5x8 in. pp. ix + 253. $1.50 net.

LABORATORY TESTS OF A CONSOLIDATION LOCOMOTIVE—By E. C. Schmidt, J. M. Snodgrass and R. B. Keller. Urbana, Ill.: University of Illinois. Bulletin 82, Engineering Experiment Station. Paper; 6x9 in.; pp. 129; 58 illustrations. 65c.

A LIST OF BOOKS ON THE HISTORY OF INDUSTRY AND INDUSTRIAL ARTS—Prepared by Aksel G. S. Josephson, Cataloguer. Chicago, Ill.: The John Crerar Library. Paper; 7x10 in.; pp. 485. 25c. By mail, 30c.

MAINTENANCE OF WAY AND STRUCTURES—By William C. Willard, Assoc. M. Am. Soc. C. E., Assistant Professor of Railway Engineering, McGill University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xxi + 451; 232 illustrations. $4 net.

THE MECHANICAL ENGINEERS' POCKET-BOOK: A Reference-Book of Rules, Tables, Data and Formulas—By William Kent, Consulting Engineer, M. Am. Soc. M. E. and Am. Inst. M. E. 9th edition, thoroughly revised with the assistance of Robert Thurston Kent, Jun. Am. Soc. M. E., Consulting Engineer. New York: John Wiley & Sons. Flexible leather; 4x7 in.; pp. xliv + 1,526; 250 text illustrations. $5 net.

THE "MECHANICAL WORLD" POCKET DIARY AND YEAR BOOK FOR 1916—Manchester, England: Emmott & Co. Baltimore, Md.: The Norman, Remington Co. Cloth; 4x6 in.; pp. 429; 87 illustrations. 25c.

METHODS OF WASHING SLOW SAND FILTERS—By John Gaub, Chemical Engineer, Filtration Plant, Washington, D. C. [Reprinted from the "Journal of the American Water-Works Association," Vol. 2, No. 4, December, 1915.] Paper; 6x9 in.; pp. 596-611; illustrated.

A useful review of current methods employed in general and of actual practice at a dozen plants.

"MINERAL RESOURCES OF THE UNITED STATES"—Washington, D. C.: United States Geological Survey. Paper; 6x9 in.

Part II, 1914: No. 32, The Production of Natural Gas in 1914. By John D. Northrop. Pp. 747-818. No. 33, The Stone Industry in 1914. By G. F. Loughlin. Pp. 819-881. Part I, 1915: No. A, The Public Interest in Mineral Resources. By George Otis Smith. Pp. 1a-9a.

PETROLEUM AND ITS PRODUCTS: Properties, Specifications and Tables—Kansas City, Mo.: Kansas City Testing Laboratory. Bulletin 9. Paper; 6x9 in.; pp. 19. 25c.

PRINCIPLES AND PRACTICE OF COST ACCOUNTING, For Accountants, Manufacturers, Mechanical Engineers, Teachers and Students—By Frederick H. Baugh. Baltimore (P. O. Box 682), Md.: The Author. Cloth; 6x9 in.; pp. xi + 194. $3.

THE PRODUCTION OF IRON AND STEEL IN CANADA IN 1914—Ottawa, Canada: Department of Mines. Paper; 7x10 in.; pp. 35.

PUBLIC SERVICE COMMISSION FOR THE FIRST DISTRICT OF THE STATE OF NEW YORK—Annual Report for 1913. Vol. III, Statistics of Gas and Electric Companies. Vol. IV, Dual System Contracts and Certificates Between the City of New York and Interborough Rapid Transit Co., Manhattan Railway Co. and New York Municipal Railway Corporation. Vol. V, Documentary History of Railroad Companies. New York: The Commission. Cloth; 6x9 in.; pp. 574; 598; 1,473.

RAILWAYS IN INDIA—Administration Report for 1914-15, Vol. I. Simla, India: Railway Department of the Government of India. Paper; 8x13 in.; pp. 53; illustrated. 2s. 3d.

REGULATIONS FOR THE INSTALLATION OF GRAVITY AND PRESSURE TANKS, CONCRETE RESERVOIRS AND VALVE PITS—Recommended by the National Fire Protection Association, Boston, Mass. Paper; 3x5 in.; pp. 88, illustrated.

REINFORCED-CONCRETE CONSTRUCTION: Vol. III, Bridges and Culverts—Prepared in the Extension Division of the University of Wisconsin by George A. Hool, Associate Professor of Structural Engineering, assisted by Frank C. Thiessen, Instructor in Structural Engineering. With chapters by A. W. Ransome, Leslie H. Allen, William J. Titus, Albert M. Wolf, Philip Aylett and P. J. Markmann, and articles by A. C. Janni and S. W. Bowen. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xxii + 688; 575 illustrations. $5 net.

THE STRUCTURE AND PROPERTIES OF THE MORE COMMON MATERIALS OF CONSTRUCTION—By G. B. Upton, Assistant Professor of Experimental Engineering, Sibley College, Cornell University. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. v + 327; 181 text illustrations. $2.50 net.

TECHNICAL PAPERS, U. S. BUREAU OF MINES—Washington, D. C.: The Bureau. Paper; 6x9 in.; pp. 11 and 43.

No. 127, Hazards in Handling Gasoline. By George A. Burrell. No. 128, Quarry Accidents in the United States, 1914. Compiled by Albert H. Fay.

THE TELEPHONE AND TELEPHONE EXCHANGES: Their Invention and Development—By J. E. Kingsbury. New York: Longmans, Green & Co. Cloth; 6x9 in.; pp. x + 558; 180 illustrations. $4 net.

TRAVELING ENGINEERS' ASSOCIATION—Proceedings of the Twenty-Third Annual Convention, Chicago, Sept. 7-10, 1915. Buffalo, N. Y. (New York Central Car Shops): W. O. Thompson, Secretary of Association. Flexible leather; 6x9 in.; pp. 400; illustrated.

TRENCHING MACHINERY USED FOR THE CONSTRUCTION OF TRENCHES FOR TILE DRAINS—By D. L. Yarnell, Drainage Engineer, Division of Drainage Investigations. Washington, D. C.: Office of Public Roads and Rural Engineering. U. S. Department of Agriculture. Farmers' Bulletin 698. Paper; 6x9 in.; pp. 26; illustrated.

UEBER GESCHICHTE UND BAU DES PANAMA-KANALES—Von a. Professor K. E. Hilgard, M. Am. Soc. C. E., Ingenieur-Konsulent in Zurich. Zurich, Switzerland: Art. Institut Orell Füssli. Paper; 7x10 in.; pp. 113; 49 illustrations. 6 marks.

WATER CONSERVATION AND IRRIGATION IN NEW SOUTH WALES, 1915—Report of Acting Commissioner. Sydney, N. S. W., Australia: The Commissioner. Paper; 8x13 in.; pp. 109; illustrated.

Field and Office

Laying a Submerged Water Main by Rope Haulage

By H. B. Hemstrought*

A 16-in. cast-iron water main was recently laid beneath the Susquehanna River for the water-works of Binghamton, N. Y., by means of a capstan on one side of the river, a cradle on the other side and a cable, supplemented for the latter part of the job by tripods set on the river bed.

Several different methods for making the crossing were worked out and discussed before the method used was decided upon. It was first thought that it would be most practicable to connect enough pipe to cross the deepest part of the river, float it out and lower it into place so that both ends could be picked up in the shallow water and the pipe laid both ways to each bank. In an ordinary season this method would probably have been the most feasible of all, as at the time of taking the sections (Fig. 1) the river was at mean low water. This plan was rendered impossible because a week after the sections were taken the river rose 3 ft., and although sometimes rising higher, never fell below the 2½-ft. mark.

Taking into consideration the high water and the velocity of the current, which was at the time of laying the pipe 11.6 ft. per sec., it was decided that the pipe could be put in place more economically by pulling it than by any other method.

A capstan was designed (Fig. 2), a special cap was cast for the end of the pipe and a cradle was built to carry the pipe down the north bank to the river. The capstan was built and set up on the south side of the river and the cradle laid in place on the north side. A sash cord was pulled across by a rowboat from the north bank to the south side of the river, and a 1-in. rope was attached to the sash cord and pulled across by hand. The 1-in. rope was then put on the capstan, and a ⅞-in. steel haulage cable, used for pulling the line, was drawn over.

*Of the Water-Works Engineering Department, Binghamton, N. Y.

Three lengths of Ward's joint pipe were made up on the foot of the cradle, the cap calked onto the head end of the line and the bridle attached. The pull was started on the morning of Oct. 15, with the 1-in. rope directly around the capstan and attached to the cable. After four lengths had been pulled into the river the 1-in. rope broke, the direct pull was abandoned and the tackle arranged as shown by Fig. 4.

Pulling was then continued steadily for five days, at the end of which time 35 lengths of pipe were in the river. The maximum number of lengths pulled in during any one day was 13. The pull was practically continuous,

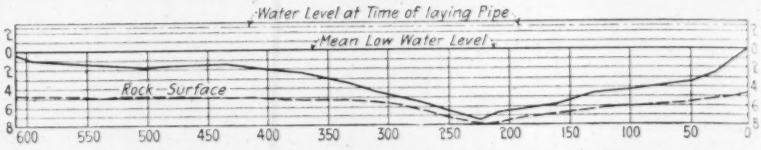


FIG. 1. PROFILE OF SUBMERGED WATER MAIN ON CENTER LINE OF PIPE UNDER SUSQUEHANNA AT BINGHAMTON

as while the tackle was being changed on the south side another length of pipe was being made into the line on the north bank.

On starting to pull on the morning of the sixth day the ⅝-in. chain holding the blocks snapped. After repairing the chain the pull was again attempted, and the 1-in. ring on the block broke. The ring was repaired and the pull barely started when the bridle on the pipe line pulled apart.

Pulling was then abandoned and the end of the pipe line raised with a tripod in 4 ft. of water. The cap was then removed from the end of the pipe and preparations made for laying the pipe as follows: Four horses built of heavy timber were placed two on each side of the line of pipe. On these horses 4x6-in. stringers 14 ft. long were laid to insure rigidity. A new length of pipe was then brought out on a scow of three tons' displacement, rolled onto the framing and swung into place with a second tripod (Fig. 3).

This new length was then calked into the line and a rope sling swung from the stringers under the line between the two tripods, as an added factor of safety while lower-

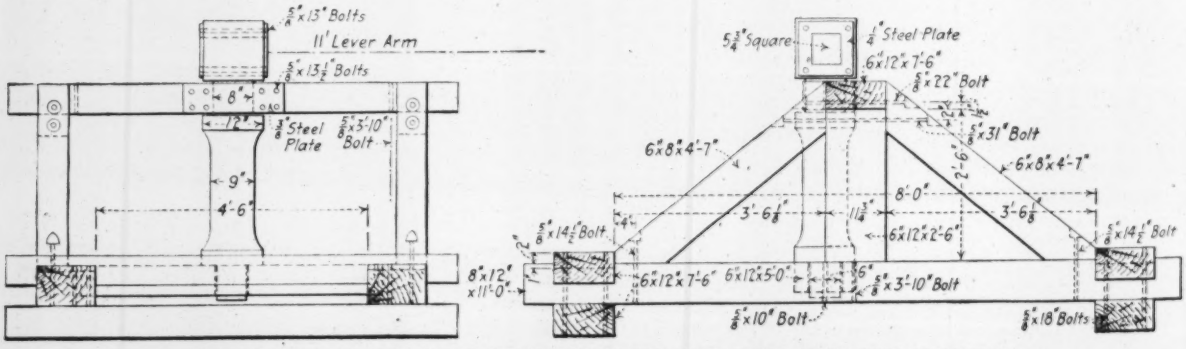


FIG. 2. DETAIL OF CAPSTAN FOR HAULING CAST-IRON PIPE ACROSS RIVER

FIG. 3. TRIPOD ON SCOW FOR PIPE LAYING

ing the line. The line was next lowered until the end of the last pipe was about 1 ft. above the water, the rear tripod brought ahead and the operation repeated until the shore was reached.

In this manner 17 lengths of pipe were laid in six days, making a total of 52 lengths of pipe laid in 12 days.

During the pull the capstan, operated by one horse, was found to develop power far in excess of that necessary, and the only difficulty encountered up to the time the chains broke was the continual slipping of the clips connecting the blocks to the main cable. At first a light type

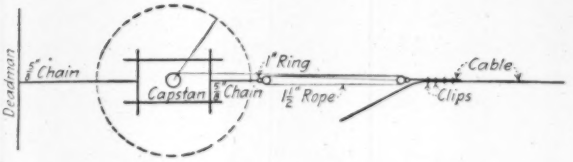


FIG. 4. REARRANGEMENT OF CAPSTAN

of wire clip was used for this purpose, but it slipped and broke. Eccentric grips and heavy wire grips were also tried, but the best results were finally obtained with a series of extra-heavy wire clips.

The total cost of laying the line, exclusive of materials, was $306.

An Articulated Trailer for Contractors' Use

A strongly constructed motor-truck trailer consisting of two 2-wheel carts coupled together, as shown in the views, was recently placed on the market by the Glen Wagon and Car Corporation, of Cortland, N. Y. The trailer, or twin trailer, as it is called, has roller-bearing axles 3½ in. in diameter and heavy white-oak wheels with broad treads; the hubs are capped to keep out dust. The wheels are tired with soft Norway iron 8x1 in. or 6x1 in., with a $\frac{3}{16}$-in. sweat band underneath. The bodies are of white oak. Each trailer cart carries 5 tons, or 10 tons is the full load of the unit. The two half-units are connected by pin coupling, shown in Fig. 1, which allows taking sharp turns easily.

The trailer has bottom dump doors; the dumping ratchet is shown in Fig. 2. Where the material to be

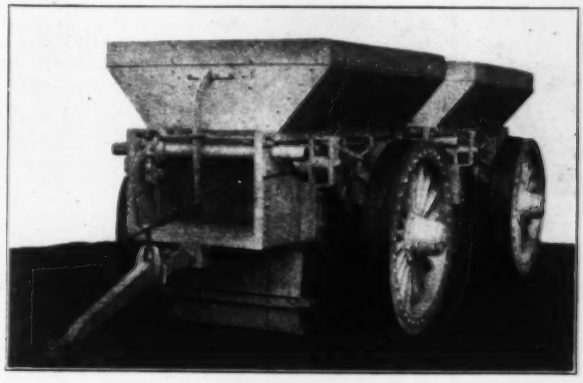


FIG. 2. VIEW OF TRAILER, SHOWING BOTTOM DOOR DROPPED IN DUMPING POSITION

Door is closed by ratchet and drum arrangement in front

hauled weighs less than 4,000 lb. per cu.yd., like stone or gravel, the bodies are built to carry 3 to 3½ cu.yd. on each trailer, or 6 to 7 yd. on the two. The trailer is built very stoutly and is guaranteed to outlast any motor truck.

On a specific job, the truck was geared down to 12 mi. per hr., although the trailers could stand 15 to 20 mi. per hr. This limit was set in order to hold the speed to a uniform rate and to eliminate the possibility of too fast driving. The draft on the truck is reduced about 35% by carrying the 10 tons on four wheels of this size instead of carrying 5 tons on four wheels, or the 10 tons on eight smaller wheels. The advantages of the twin carts are their flexibility on sharp turns which permits of their easy management under the many variable and severe conditions imposed in contractor's hauling.

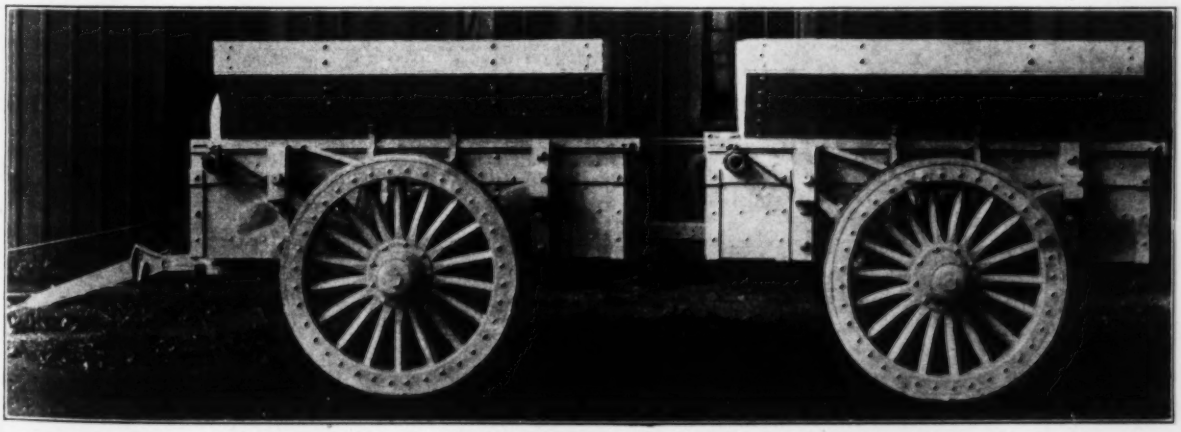
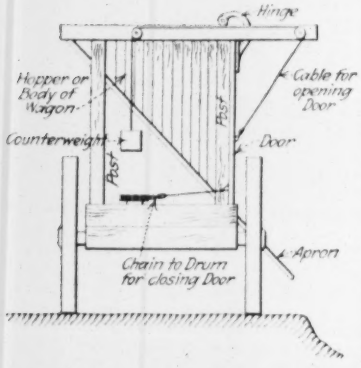


FIG. 1. SIDE VIEW OF TWIN TRAILERS; COMBINED CAPACITY, 10 TONS

Side-Dump Cart for Backfilling

For backfilling large sewer trenches in Chicago a special dump wagon with side delivery has been devised and built by the contractor, the W. J. Newman Co. It is shown in the accompanying drawing. The body is of triangular section, with the vertical side closed by a door hinged at the top and the sloping side extending between the wheels to serve as a chute or apron. Two posts at each side of the hopper carry cross-timbers which extend beyond the door and carry sheaves for the door cables, the cables leading back over the other sheaves and having counterweights attached to their ends. The hinges are of angle shape, so as to throw the door clear of the hopper. The door is closed by lines led to a chain from a ratchet drum operated by the driver.



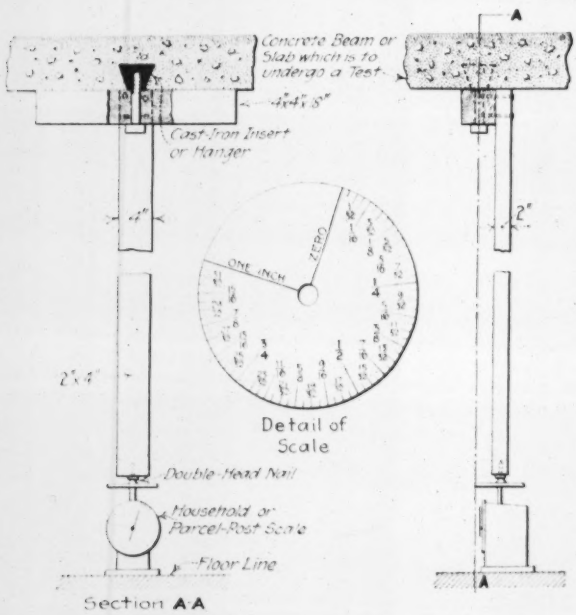
SIDE-DUMP WAGON FOR BACK-FILLING TRENCHES

Using Household Spring Scale to Magnify Deflections

Ordinary household spring scales were used successfully in measuring the deflection of the girderless floor slabs of the International Harvester Co.'s new reinforced-concrete building at Cincinnati, Ohio. The accompanying sketch shows the method in which the scales were used.

A 4x4-in. stick was first spiked as a top crosspiece to a 2x4-in. stud, and the frame thus made nailed to a 1x4 attached to the bolt of a ceiling insert in the slab to be tested. A double-headed nail was then driven into the bottom of the stud and centered over the stem of the spring scale, which was wedged under the stud high enough so that the pointer turned about 30° below the vertical.

On the dial of the scale was then fastened a paper dial, scaled as shown in the detail in the drawing, with the zero of the new dial opposite the pointer. Any movement of the floor-slab under load was thus transmitted to the scale and read in its exact amount on the new dial. This dial was calibrated by noticing the angular movement of the pointer under a vertical movement of 1 in. of the scale plate and dividing the dial proportionately to that amount. The zero was placed at the right of the vertical to permit an upward as well as a downward movement of the slab to be observed.



AN ORDINARY SPRING SCALE CALIBRATED TO MEASURE FLOOR-SLAB DEFLECTIONS

Six of these scales were used in making the loading test on the first-floor slab of the building. The deflection allowed by the specifications was $^1/_{1000}$ of the diagonal span under a combined live- and dead-load of 350 lb. per sq.ft. The slab was loaded to 645 lb. per sq.ft. before the deflection reached $^1/_{1000}$ of the diagonal span. The building was designed by Stegner & Hughes, Cincinnati, Ohio, and erected by Roos Bros., of the same city.

Brooming of Piles in Driving with Steam Hammers

By Rudolph N. Maxwell*

In driving piles for the foundation of approach walls for the Runnymede Ave. bridge over West Fork Creek, Cincinnati, a steam hammer was used, handled by a stiffleg derrick. The piles were precast concrete piles of octagonal section, tapering from 14 in. at the butt to 7 in. at the small end, and were from 25 to 30 ft. long. In driving them the unsteadiness of the hammer produced a considerable amount of brooming of the piles, but the banding of the reinforcement limited this brooming in all cases.

To save time it was found convenient to use a templet and guide-frame, the arrangement being as follows: The piles were set upright in a group before any were driven. They were held vertically by a scaffolding or horizontal guide-frame of 2x12's laid flat, built about 12 ft. above ground, the pockets between the boards directly over each stake being a little larger than the diameter of the pile. When a group was thus set up and held by the guide-frame, the hammer was started and all the piles were driven successively to near the horizontal guide-frame, or about one-half their length, after which the frame was removed and the piles driven the rest of the way without trouble as to lateral displacement.

A 2-in. block of hard wood, used as a cushion on the pile-head while driving, helped to prevent excessive brooming. The hammer had a ram weighing 1,500 lb., delivering 110 blows per min. under a steam pressure of 90 to 100 lb. The driving for some feet was easy, but later it became very hard; in one case the pile penetrated the ground only ½ in. under 40 blows. Some of the piles received more than 1,000 blows.

Where it was possible to keep the hammer steady at all times, no brooming was noticeable except for a few inches around the outer edge of the pile. Where the hammer wavered considerably, the piles broomed a foot or so, but

*3541 Trimble Ave., Cincinnati, Ohio.

the brooming stopped at the uppermost band (¼-in. bands were used, spaced not over 6 in. apart and placed around eight ½-in. rods at the corners of the octagon).

When the top of the pile broomed for a foot or more, the part below the brooming showed no visible flaws. This was the case even when the finished pile projected as much as 7 or 8 ft. above ground.

The piles were later cut off a foot above ground, the longitudinal rods being cut off 1 ft. above this level by means of a hacksaw, in order to bond the tops of the piles and the projecting steel into the work above.

Pile Formula Overruled by Test

An aggravated case of poor results secured from a pile formula is reported from Boston. The automatic pumping station of the South End sewer system, just completed, is located in soft ground, and piles had to be driven to make the foundation. The weight to be carried and the peculiar subsoil made it necessary that the safe pile-loading be determined. A pile test was made, and the results obtained disagreed radically with the figure found by pile formula.

According to a description presented before the Boston Society of Civil Engineers by E. S. Dorr, former chief engineer of the sewer division, Boston Street Department, the soil at the site consists of 37½ ft. of soft silt overlying a 3½-ft. layer of stiff blue clay, which itself rests on 39 ft. of soft clay or silt. The pump pit was to go down to within 5 ft. of the stiff clay. The problem was whether to carry the weight on short piles driven only to this stratum or on long piles penetrating through it into the soft clay below and carrying by skin friction.

For the test, a 25-ft. pile was driven into a special test-pit dug to foundation level; its point went about 17 ft. below the stiff-clay stratum. Using a pile formula, the penetrations while driving gave a safe load of 4 tons. Test loads were then applied in slow stages during a 14-day period and settlements observed. The results were:

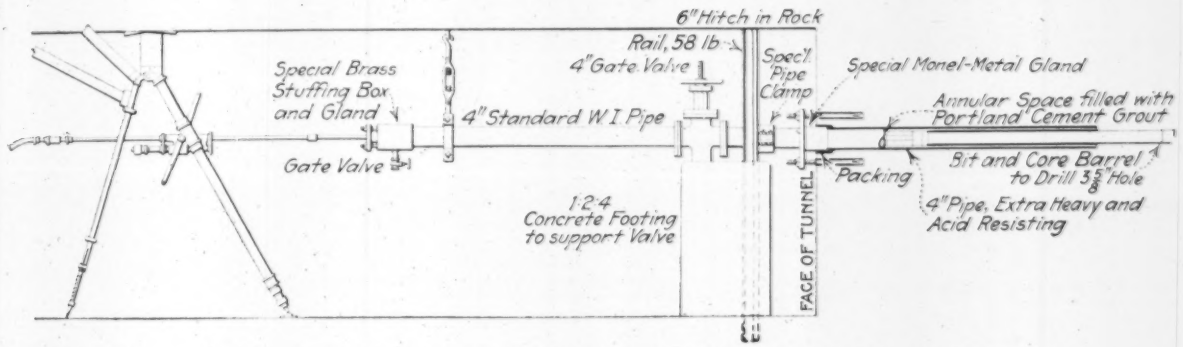
1913	Total Load, Tons	Settlement, Ft.
Aug. 4	5.43	0.005
Aug. 6	10.43	0.017
Aug. 8	15.43	0.020
Aug. 11	20.43	0.027
Aug. 13	25.43	0.032
Aug. 18	30.43	0.057
Aug. 18	35.43	0.159

The engineers concluded that these figures warranted a considerably higher loading than that found from the pile formula. The final decision, based more on judgment than on the test figures, was to load the piles to 8 tons, using 25-ft. piles driven down through the stratum of stiff clay and entering some distance into the soft clay, like the test pile. This scheme was carried out.

The pump pit above which the station was built was excavated about 30 ft. below ground. The sheeting, 6-in. splined Georgia pine, put down to the clay stratum showed the great pressure of the silt, but cross-bracing prevented trouble, except that there was a slight rising of the middle piles. The 3-ft. capping slab of concrete, placed as quickly as possible, checked the rising before it became serious.

Tapping High-Head Mine Water Through a Stuffing Box

Two large subterranean bodies of water under heads of 150 ft. and 300 ft. respectively were tapped through a stuffing box and a gate valve by the Lehigh Valley Coal Co. this summer. The operation was described by A. H. Lewis, division engineer, in the *Employees' Magazine*, published by the company. The drill steels were removed


6"Hitch in Rock
Rail, 58 lb.
4"Gate Valve
Spec'l. Pipe Clamp
Special Monel-Metal Gland
Special Brass Stuffing Box and Gland
4"Standard W I Pipe
Annular Space filled with Portland Cement Grout
Gate Valve
Packing
Bit and Core Barrel to Drill 5⅝"Hole
1:2:4 Concrete Footing to support Valve
4"Pipe, Extra Heavy and Acid Resisting
FACE OF TUNNEL

DRILLING ARRANGEMENT FOR TAPPING HIGH-HEAD WATER UNDERGROUND

without difficulty in both cases and the chambers remained dry.

At the Stockton Shaft Colliery, in Pennsylvania, there was a basin of water 2 mi. long and 300 ft. above the point selected for starting the drainage hole. The first 6 ft. of the hole was made 5½ in. in diameter to allow for grouting in a 4-in. bronze pipe. There were no bits on the job large enough to drill to this diameter, so a bit was constructed by setting diamonds in the end of a piece of 5-in. steel pipe. The other end of the pipe was drawn down to fit the drill rod. The first 4 in. of the hole was moiled out to a diameter of 6⅞ in. to accommodate the gland, which when drawn up on the packing placed around the pipe was designed to take care of leaks and help hold the pipe in place after the water had been struck.

The set-up consisted of two 58-lb. rails which were hitched 6 in. in the top and bottom and cemented in place. A pipe clamp placed around the pipe rested against the rails. A 4-in. acid-resisting, easy-flow gate valve was then bolted to the bronze pipe, which was supported on a concrete pedestal. A piece of 4-in. W. I. pipe, 5 ft. 6 in. long, to accommodate the core barrel, was attached to the gate valve and supported from the roof by a turnbuckle hanger, as shown in the sketch. On the end of this pipe were screwed the special brass stuffing box and gland.

A hand pump forced water through the drill steel to the face of the hole to carry away the cuttings, the water escaping through a 1-in. gate valve on the stuffing box.

The gland normally was pulled up just tight enough to prevent the water from leaking out around the drill steel, but when water was struck the gland was pulled up tight. To remove the rods, the bolts of the gland were loosened. When the core barrel had been pulled out until it was entirely within the 4-in. pipe the bronze valve was closed and the stuffing box and gland and the 4-in. pipe were taken down. A second gate valve was fastened to the one already in place and the flow controlled by this outer valve, the inner one being retained as an emergency valve.

At the Beaver Meadows (Pennsylvania) Colliery of Coxe Bros. & Co., Inc., 4,500,000 gal. of water was drained from a vein by the same method as was used at Stockton Shaft. The head here was 150 ft. The drill hole was 3⅝ in. in diameter and 202 ft. long.

Two Culvert Foundations

Among the concrete culverts constructed along the line of the new Chesapeake & Ohio Northern Ry., now building in Ohio, there are two worth particular notice on account of their foundations. One is a reinforced-concrete box culvert on the Kentucky side of the Ohio River within a few hundred yards of the large Ohio River crossing of the railway; the other is in what is known as the Dan White Hollow fill and is a 16-ft. arch culvert with a barrel 200 ft. long. Both culverts were built under the direction of H. B. Watters, resident engineer, Chesapeake & Ohio Northern Ry. The contractor was W. W. Boxley & Co. (J. W. Goodwin, superintendent).

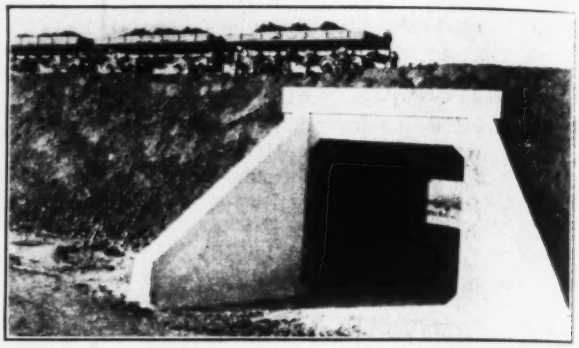
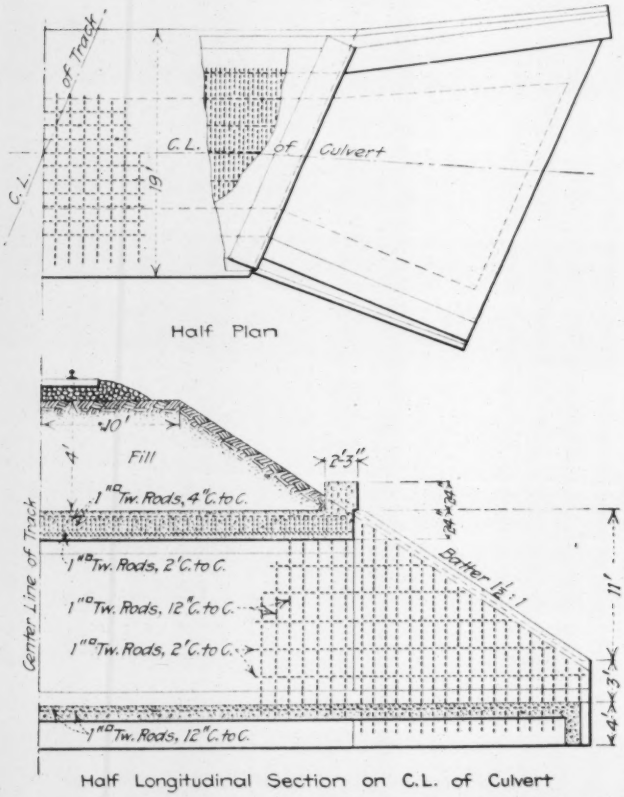


FIG. 3. THE CULVERT ON KENTUCKY SIDE, WITH FILL TO GO 25 FT. HIGHER

The culvert on the Kentucky side is a private road crossing built on a skew through a 55-ft. earth fill. The soil here is rather mucky clay when wet. The shallow foundation (Fig. 1) was not built directly on the clay, but on a cushion course of mixed gravel and sand. First the ground was cleared and excavated to a depth of about 3 ft., and then a fill 1½ ft. deep of gravel and sand, which had been run through a mixer, was placed. This bed after it had been tamped provided a dry, level and firm bearing for the foundation.

The footings and pavement were poured first; then the bench walls were placed by a derrick. The bottom forms for the culvert were first covered with mortar because the reinforcing rods were spaced so closely that there was no room to spade; then the concrete was placed. Placing the mortar first produced a smooth surface. The



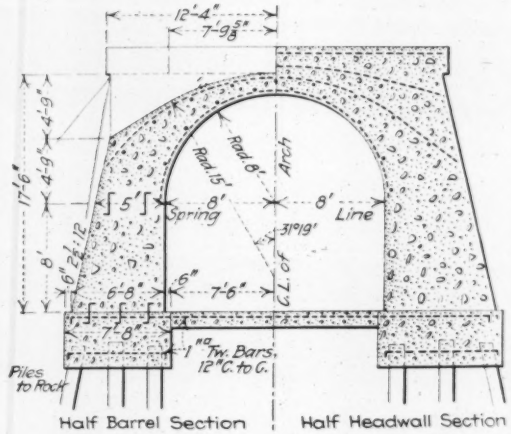


FIG. 2 ARCH CULVERT IN DAN WHITE HOLLOW

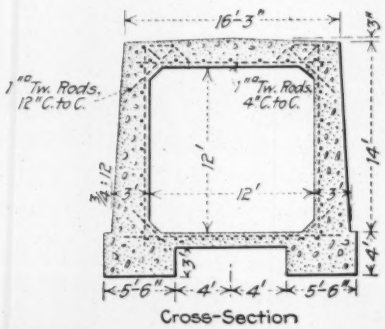


FIG. 1 CONCRETE BOX CULVERT IN KENTUCKY

FIGS. 1 AND 2. DESIGN OF BOX CULVERT AND CROSS-SECTION OF CONCRETE ARCH CULVERT ON CHESAPEAKE & OHIO NORTHERN RY.

...lvert was waterproofed on top, on the sides, and on the ...k of the wings.

The concrete was allowed to set for three weeks, after ...ich the filling proceeded on each side toward the cen... Half of the fill over this box is now in place, and ... settlement or cracks have been observed in the con...ete.

FOUNDATION FOR ARCH CULVERT UNDER 75-FT. FILL

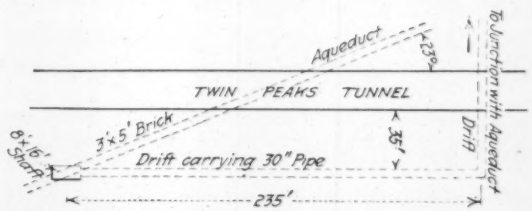
The design of the arch culvert in Dan White Hollow is given in Fig. 2. The soil here is not good material, so to provide bearing for the culvert 500 piles were put down about 16 ft. to rock. The tops of the piles were embedded in concrete and tied together with reinforcing rods, as shown in Fig. 2. The foundation walls were tied together through the 12-in. pavement, as shown. The latter ties, or rods, take up the tension in the event of the pavement bulging on account of the pressure of the fill on the arch. Expansion joints were formed every 28 ft. The outer piles were driven on the same slope that the back of the walls was to have.

Some quicksand was encountered, and when this occurred the piledriver was elevated 5 or 6 ft. and longer piles were driven, after which the quicksand was excavated and the piles sawed off to the proper elevation.

Diverting an Aqueduct During Tunnel Construction

In building the new Twin Peaks highway tunnel in San Francisco a rather difficult problem was recently presented in advancing the tunnel under a 3x5-ft. brick aqueduct through which the Spring Valley Water Co. supplies the "Western Addition" district with water.

The aqueduct crosses the line of the tunnel on an angle of 23° (see accompanying plan) and at an elevation of 8 ft. above the top of the concrete tunnel lining. The material traversed at this location is a very wet, loose sand. As the ground water drains into the tunnel, the entire formation settles, so that it would be extremely dangerous to rely on the aqueduct remaining stationary while the tunnel was being excavated beneath it. For this reason a single 8x16-ft. shaft was sunk 35 ft. from the easterly wall of the tunnel. This shaft intercepted the aqueduct at a depth of 65 ft. From the point of intersection a drift was run northeasterly parallel to the line of the tunnel for a distance of 235 ft., thence at right angles across the line of the tunnel until it again intersected the aqueduct. Through this drift a 30-in. pipe was laid and the entire flow directed through it. The tunnel excavation was then advanced under the aqueduct.



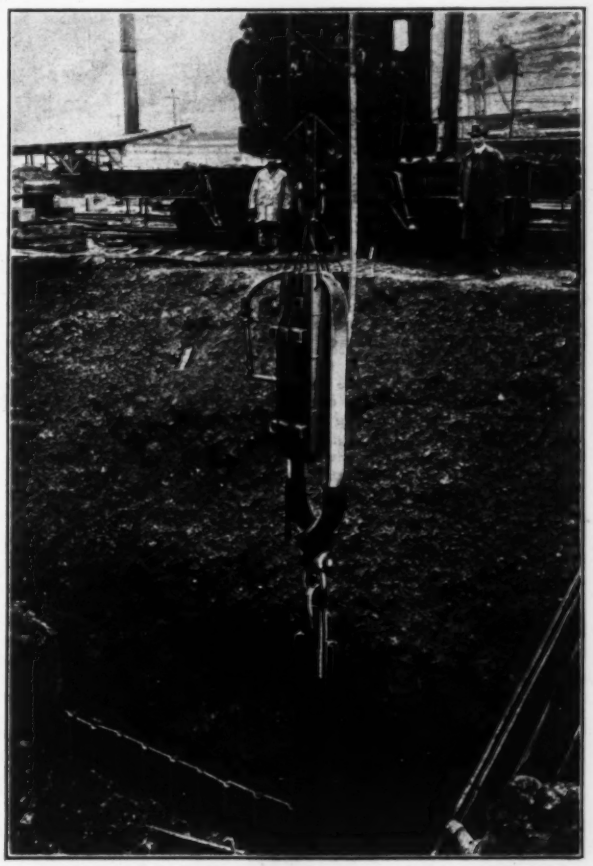
LAYOUT OF DIVERSION PIPE, TWIN PEAKS TUNNEL

At this time it is impossible to say whether the brickwork was injured due to settlement, but it is probable that it will have to be repaired before using. The aqueduct carries 18 million gallons daily in summer and 9 million gallons in winter. The capacity of the diversion pipe is only 9 million gallons.

NOTES

Construction Work by Municipal Day Labor is claimed to have saved the city of Flint, Mich., $43,000 in 1915. More construction work was undertaken by the city than in any previous year. The work was done almost wholly by day labor and consisted of 7.2 mi. of pavement, 20 mi. of sewers, 7.23 mi. of sidewalks and 74 crosswalks. In most instances the city decided to do its own work after having received bids from contractors, which were considered unsatisfactory. The sums saved over contractors' bids are said by E. C. Shoecraft, City Engineer, to be as follows: $24,000 on paving, $15,000 on sewers and $4,000 on sidewalks, bridges and walks.

Steel Sheetpiling Is Being Pulled by an inverted steam hammer at the rate of a pile in 1½ min. by the McKelvey-Hine Co., of Pittsburgh, Penn., in the construction there of the foundation of the Pittsburgh & Lake Erie warehouse. Before any piling is driven for coffer-dam, the earth is excavated to a depth of 30 ft. Then 14-in. Lackawanna piles are driven all around the pit to their full depth of 35 ft. The earth inside is removed to the 60-ft. level. This leaves about 3 ft. of pile below the bottom of the excavation.

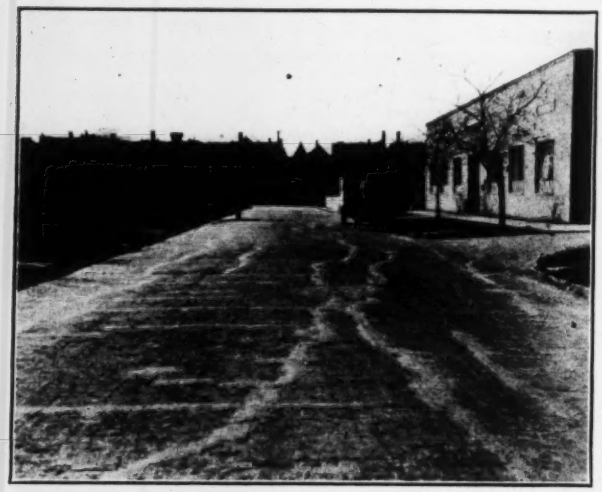


INVERTED STEAM HAMMER PULLING A 35-FT. SHEETPILE

The 60-ft. depth is below the bottom of the adjacent river, so that the excavation is wet even after the piling has been driven to full depth. After the excavation the water is pumped out and concrete is placed in the bottom to a depth of 5 ft. No tar paper or other separator is placed to prevent the concrete from bonding to the steel piles.

The piling is pulled after the concrete work is finished and the bracing has been removed and the pit refilled practically to the top, leaving only sufficient clearance to give the hammer a connection. The hammer, one of the McKiernan-Terry Drill Co.'s, weighs 2,900 lb., has a 400-lb. ram and delivers 275 blows per min. at 8¾-in. stroke. It is suspended from the arm of a locomotive crane, as shown in the view.

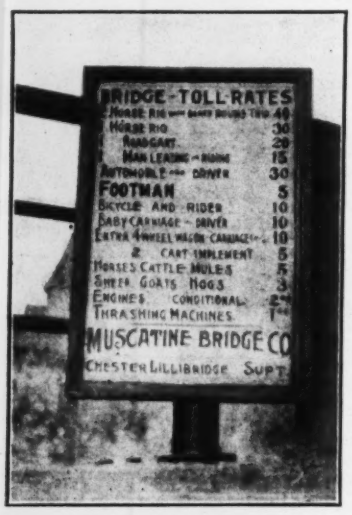
For Making Patches and Filling Cracks in brick pavement the Street Repair Department of Cleveland, Ohio, is using a mixture of asphalt, lake sand and silica gravel (⅛ to ¼ in.). The proportions by weight are about 1½ : 1 : 2. The ingredients are heated and mixed together in a "Special Archer Mixer," made by the Archer Iron Works, of Chicago. When cracks have been thoroughly cleaned and filled with this



ASPHALTIC GRAVEL CONCRETE FILLER FOR BRICK PAVEMENT DEFECTS; CLEVELAND, OHIO

material, the results are said to be very satisfactory. The Street Repair Department also uses the same mixture for patching depressions in both brick and stone pavements, and in some instances for quite extensive resurfacing. The accompanying view shows a portion of a brick pavement on Chester Ave., repaired by the method described. P. J. Masterson is Superintendent of the Cleveland Street Repair Department.

Escaping Acid Ate Hole in Cast-Iron Pipe—Waste sulphuric acid from a shoddy mill, escaping from a broken or clogged vitrified pipe, ate an irregular hole, about 2x1 in., in a 20-in. cast-iron line of the Kennebec Water District, at Waterville, Me. The cast-iron pipe was below. The action of the acid was noticeable for a length of about 3 ft., but there was no honeycombing. There were several bands of corrosion along the under side of the pipe. The acid pipe was diverted to a new location. The cast-iron pipe was repaired by surrounding the part affected by a split cast-iron sleeve 4 ft. in length, packed with rubber gaskets and bolted together. The ends of the sleeve were loaded and calked in the usual way. At first the sleeve leaked at the joints, but these leaks stopped within 12 hr., and the sleeve was entirely surrounded with concrete well reinforced. The concrete sleeve was extended far enough in each direction to make certain that it protected the iron from any acid in the ground.—H. P. Eddy in Journal of the Boston Society of Civil Engineers.

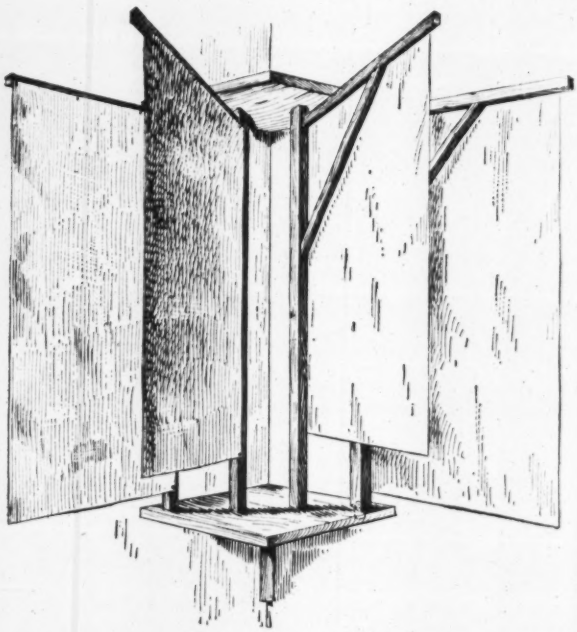


COMPREHENSIVE SCHEDULE OF BRIDGE TOLLS

Bridge Toll Schedule—The accompanying view of a list of bridge tolls of the Muscatine Bridge Co. was sent by a correspondent who calls attention to the charge for a "baby carriage and driver."

A Mistake in a Contractor's Bid caused a little trouble in Milwaukee recently. One contractor bid $1,694 in figures and in writing, while the other put $1,694 in figures but wrote "sixteen hundred and ninety-five." There was some discussion as to which amount was intended. The Commissioner of Public Works was advised by the City Attorney that the latter bid was informal, and the former bid was undoubtedly the lower. The contract was let in accordance with this opinion.

Corner Rack for Blueprints—A type of rack not often used, but very convenient, is sketched herewith from a Washington, D. C., contracting office. The feature is placing the vertical shafts on the diagonal of the bracket boards so that any or all of the leaves can swing to a position parallel to either wall. The method of fastening blueprints to racks of this type may vary according to the needs of the case. In the simplest cases, where only one or a small number of prints are to be hung from each arm, thumbtacks or the like to pin the prints directly to the top member of the arm are sufficient.



CORNER BLUEPRINT RACK IN A CONTRACTING OFFICE

Where a large collection of prints is to be hung from one arm, some arrangement of clamping strips is preferable. By using a pair of clamping strips to hold the drawings and laying these in hooks or sockets on the arm an arrangement is obtained in which the whole set of prints on any arm can be taken down and laid on the table for better inspection.

Driving the Silver Rivet was the ceremony substituted for the antiquated laying of the cornerstone, in the case of the Heckscher Building, 42nd St. and Madison Ave., New York. The owner drove a solid silver rivet, 1 in. in diameter by 8 in. long, in the first steel set in place, a few weeks ago. The framework is now nearing completion.

Protecting Mortar Joints in Sea Walls—In building sea walls of coursed granite masonry laid in mortar and exposed to the action of tidal currents, where the bottom course is not more than one foot above mean low water, much difficulty is often encountered in holding the mortar in the joints long enough to give it time to set, as the action of the tides rising and falling on the fresh mortar will pull it out of place. It does not matter how rich a mixture is used, whether 1:1 or neat cement, it is impossible to keep the mortar in place till it hardens. On one piece of construction under the writer's supervision this difficulty was successfully overcome by mixing plaster of paris with the mortar in the proportion of one part of plaster of paris to three parts of 1:1 mortar. This mixture hardened within five minutes, and no further trouble was experienced from the mortar in the joints failing to set in place, and the pointing of the joints in which this mixture had been used was entirely satisfactory.—John L. Howard, before Boston Society of Civil Engineers.

Editorials

Has a Turning Point Come in Federal Waterway Methods?

Few men in the United States outside of the engineering profession are as competent to speak with authority on the work done by the Federal Government for waterway improvements as is Ex-Senator Theodore E. Burton, of Ohio, one of the leading candidates for the Republican presidential nomination. In *Munsey's* for January, Ex-Senator Burton makes a scathing arraignment of Federal expenditure on waterway improvements. He cites not one but a dozen cases where the Government has expended hundreds of thousands or millions of dollars on works for improving navigation on interior rivers, but the commerce which it was intended to serve has entirely vanished from the improved waterway. The following quotation from the article is a typical example:

> On the Big Sandy River, on the boundary between Kentucky and West Virginia, together with two of its branches, five locks and dams have been built at a cost of $1,700,000 and $260,000 additional for maintenance. The original advocates of this costly undertaking declared that owing to the nature of the country no railroads could be built into the valley of the Big Sandy and that the project was essential for bringing out of the valley enormous deposits of coal. As a matter of fact, in 1913 just 12 tons of coal were carried through the Government's locks, while the statistics of one railroad which taps that region showed that it hauled nearly 2¼ millions of tons from the valley in 12 months.
>
> In spite of these facts, it has been strongly urged that the Government continue the building of locks and dams farther up the river, 16 additional locks being proposed at an estimated cost of $1,875,000. The army engineers have seen, however, the futility of the whole Big Sandy project and have recommended that further work be abandoned. . . .
>
> Some day in the future our descendants will stand before the monumental locks and dams on some of our minor rivers and wonder why they were ever built.

The criticism may be made that Senator Burton during his long term of service as Chairman of the River and Harbor Committee of the House of Representatives had greater responsibility than any other person in the country for the wasteful expenditure of money on these foolish internal-navigation schemes. The answer to this criticism is that it is the system and not individual men that are at fault. So long as the public measures the value of its congressmen by the appropriations which they can secure to be spent in their home districts for river and harbor work and for public buildings, so long will the dominant question at Washington be how to find ways to spend money, not whether the expenditure of the money will yield any real public benefit.

The engineering profession, however, cannot wholly escape blame for this wasteful use of public funds. Engineers were slow to understand the revolutionary change in economic conditions resulting from the development of railway transportation. Senator Burton points out clearly that the underlying reason for the failure of the inland-waterway systems is that the public went on improving channels for river-steamboat traffic after the river steamboats had become obsolete. "The reason for the recent decadence of waterway traffic is that railway carriage is more convenient, more prompt, less dangerous and is rapidly becoming more economical. We should face these facts without prejudice and study the transportation problem in its true light. We must recognize that just as the wagon gave way to the canal boat and later to the freight car, so waterway transportation must give way unless it can show its value."

While Senator Burton condemns the waste of public money on the slack-water navigation of inland streams, he speaks in high praise of the results of Government expenditures on seacoast harbors and on certain rivers where water transportation has been demonstrated to be an economic success. It is significant indeed that such an arraignment of past governmental wastefulness should come from a candidate for the presidential nomination. It is evident that a turning point in the methods of carrying on the Federal public works may be near at hand.

Foundation Practice and Study of Soil Properties

A striking presentation of our extensive ignorance in the matter of foundation loading and the physical qualities of soils was made last month before the Pan-American Scientific Congress by R. A. Cummings, of Pittsburgh. Mr. Cummings has the distinction of being chairman of the American Society of Civil Engineers' committee on foundation soils, and we must presume that his convincingly expressed showing of what we do not know about foundation soils is the result of his two or three years' work on this committee.

It is quite important to distinguish the practical from the scientific phase of the subject—as to both of which Mr. Cummings says we know practically nothing. The scientific, or laboratory, side deals with such descriptive knowledge of soils as would enable us to take any particular soil, recognize its similarity to others, measure its physical properties, and so forth. While this would be entirely practical in its nature, inasmuch as it would have no ultimate scientific purpose—it would not help in determining atomic weights or in deriving physical laws—yet it would be a laboratory subject, not a practical field matter.

The practical side, on the other hand, comprises the ability to recognize and measure the load-bearing capacity of a soil. Contrary to what may be thought, this ability does not exist today. The common idea is that any engineer by making a load test of a given soil can determine with fair approximation how much load he may put upon it; but this idea is far too optimistic. No two men agree on how to make a soil-loading test, and none agree on the proper interpretation of the figures and curves obtained in such tests. Very few engineers have ever bothered their heads about the question whether a yield point or similar loading limit exists for soils, where it is located and how its location may be determined.

That under these conditions so much successful foundation work has been done since the world began is almost

wonderful. It testifies to the remarkably good practical judgment that has been exercised by builders in all times and in all parts of the world. With respect to modern structures considered by themselves, it is fair to say that in foundation work the empirical judgment of engineers and builders has accomplished as much as in other fields of construction has been accomplished by the most careful scientific study and analysis.

Part of the successful foundation work that is done involves undoubtedly very great waste. The factors of safety are probably extravagant in many instances. But the amount of waste, whether much or little, and the reason for satisfactory or unsatisfactory foundation work, cannot be appreciated until a good knowledge of foundation soils has been obtained. The work of the committee mentioned may bring about important progress in this direction.

The Septic Tank as a Cure-All

Rarely has an engineering device or method had such country-wide adoption as the septic tank. Advertised in the British engineering papers as producing no sludge, requiring no chemicals and giving off no odors, this new-old method of sewage treatment was adopted in America, and soon the whole country was dotted with septic tanks. By a most unfortunate mischance a popular notion got abroad that the septic tank was itself a complete means of sewage treatment; and worse yet, that once installed it needed no further care or thought. True, where engineers versed in sewage disposal were called in, the septic tank was given its proper place as a mere clarification process, sometimes sufficient by itself to meet local needs and sometimes only preparing the sewage for its main treatment—at the same time reducing the volume of tank sludge for final disposal, as compared with ordinary settling tanks. But some engineers not versed in sewage treatment, and the generality of city officials and of physicians suddenly interested but wholly uninformed in municipal sanitation, have persistently regarded the septic tank as a do-it-all and cure-all.

An apparent instance of the cure-all notion, which seems to have the indorsement of a firm of well-known consulting engineers, appears in a recent report on improving the water-works of a city somewhere between the Gulf of Mexico and the Arctic Circle. This report recommends "that legal steps be taken to compel the use of a modern septic-tank installation for sewage from" an institution located on a creek that discharges near the water-works intake.

Of course in the loose language so commonly used by laymen and doctors, a "modern septic-tank installation" may mean almost anything appended to a septic tank. Stretched to include septic tanks as a preliminary process, sand filters as the main reliance, and disinfection as a finishing process, and assuming a higher grade of operation for the recommended "installation" than the investigators found was true of the operation of the water-works under investigation, the proposed "installation" would lessen though it would not entirely remove the danger to the water-supply. But the use of such vague language, in a report addressed to laymen city officials, is likely to mislead. Even if those who made the report had a clear idea of what sort of "modern septic-tank installation" might serve the purpose, the lay city officials would not, and therefore might be at the mercy of any fake septic-tank promoter who might gain their ears—and there are such promoters and they do gain the ears of lay city officials.

Hundreds of ill-advised septic tanks scattered over the country testify to nose and eye the waste and harm that come from a widespread misconception of what the septic tank is and does, how it should be designed, how built and how operated. Thanks to commercialism, the evil is spreading. Septic tanks are being put in without the slightest knowledge of whether they will do the required work. Commercialism is not alone responsible for the spreading evil. Popular and medical writers on health and sanitation have done their best—or worst—to spread the notion that a septic tank is a complete system of sewage treatment.

The facts are that not the farmer, the institution manager, the village councilman, no, not even the popularly elected department head under the commission-government plan can wisely and safely decide just what method of sewage treatment is best suited to meet his particular needs, any more than can every man be his own doctor or lawyer. Safety and economy demand the employment of an engineer to decide on the best method for a given case and then to design whatever works are called for and to give instructions as to their operation.

There can be no doubt as to the practicability of this course for the city, the village, the institution or country hotel. Plausible arguments can be advanced against the feasibility of employing an engineer to design farmhouse sewage-disposal plants, but it is often perfectly feasible to do this and would generally pay well in the long run. If in some cases it is not feasible, then the farmer or other small householder will do best if he adopts the simplest possible method of sewage treatment—if indeed he attempts to have a water closet instead of an earth closet or pail. For some farms and farmers, a septic tank, supplemented if need be by further treatment, may be the proper thing. Others may do better to rely upon the old-fashioned cesspool, with tight or loose walls according to local conditions. This is sound commonsense—the foundation of all good engineering. The general idea is in line with advice given by Theodore Horton, chief engineer of the State Department of Health of New York, in one of a series of articles on farm-sewage disposal recently published in *Health News*, the monthly bulletin of the department.

Finally, the septic tank, as many but not all the readers of *Engineering News* well know, is no cure-all or do-it-all. It removes a large part of the settleable solids from sewage, and by retaining them in the bottom of the tank reduces their volume. The two-story settling or septic tank, devised by Travis, improved by Imhoff and now generally used in place of the original one-story tank, produces a sludge more easily handled and less likely to give off offensive odors than does the old form of tank. This form of septic tank some writers and promoters do not appear to have heard of as yet. It is not suited to all conditions, it gives rise to trouble in some cases and like the original septic tank, produces an effluent teeming with bacteria and liable to offensive putrefaction. These two qualities do not condemn the process to those who know what it is expected to accomplish. They strike with surprise those who have been fed on the current misinformation and fragmentary information current ever since the septic tank gained a footing in this country.

Letters to the Editor

Seven Years' Growth in Railway Traffic and Facilities

Sir—In your issue of Jan. 6, in discussing the railway freight blockade at Atlantic seaports you refer to the last great railway freight blockade in 1907 and to the enormous extension of railway facilities which has taken place since that time. It may be of interest to your readers to have some figures on the growth of railway traffic and the growth of facilities for handling that traffic that have taken place in the last seven years. The figures given herewith are taken from a paper by Ivy L. Lee, read at the recent meeting of the American Association for the Advancement of Science, and were compiled by the Bureau of Railway Economics.

As most of your readers will recall, the railway traffic of 1907 far exceeded all previous records and so overwhelmed the facilities for handling the traffic as to produce the unprecedented car shortage and freight blockade referred to in your editorial. In the seven years following 1907, however, the increase in railway traffic has been so great that in the year ending June 30, 1914, a period when general business activity was at a low ebb, railroads of the United States carried 51,708,500,000 more ton-miles of freight than in 1907 and 7,540,000,000 more passenger-miles. To get a concrete idea of what these figures mean, it may be said that they are equivalent to about the total traffic of the Pennsylvania and the Santa Fe railway systems combined.

In order to handle this increased business, the railway companies of the United States have invested about $4,500,000,000 in improvements and extensions. The reported large expenditures of the New Haven system in further increasing its facilities indicate that still more needs to be done to enable the railways to handle the steady growth in traffic. B. C. W.

New York, Jan. 10, 1916.

Steel "Fatigue" at Low Stress Due to Flaws

Sir—I was particularly interested by your article and editorial in the issue of Dec. 30, dealing with the Division St. bridge failure in Spokane, Wash., as I made an investigation and report upon this accident for Spokane County. My report embodies the substance of my testimony before the coroner's jury. [Extracts are given herewith—Editor.] This report avoided detailed technical discussion, being intended to clear up certain points of responsibility, and it is planned to follow it with a later full report after the collection of additional data.

I wish you to note that my report disagrees with that of the Board of Engineers employed by the Washington Water Power Co., who assigned the failure to crystallization or granulation in service. I mentioned fatigue under what I believe to be its true definition—the spreading of microscopic flaws and cracks. The effect of fatigue in good material is known only under stresses approaching the elastic limit, but in poor material, possessing larger flaws which in effect reduce the sectional area, I consider that the word can be used under the same definition for phenomena leading to failure at stresses well below the general elastic limit of the material.

In my report fatigue was simply made an incidental suggestion. The statement that "the stress in the lower-chord end panels at the time of failure was as great as they ever had carried," although still within allowable limits so far as they may be calculated, was the real basis for conclusions.

While in Spokane I heard first-hand the stories of damage to the bridge in the year 1894. Although there was a difference of testimony, the most competent observers said that the damage was at an entirely different panel, and I dismissed this theory. Since that time a letter from the man who repaired the 1894 damage confirms the testimony that the injured eye-bars were near the middle of the span.

The expansion shoe of the Spokane bridge was of unusual type, the end pin suspended by short links about 2 ft. long from the shoe pin. Ill-designed in the first place, it is probable that due to rust, dirt and pin friction it came far from its purpose in giving free expansion and contraction. The possibility of temperature stresses having contributed to the failure of the bars adjacent to this shoe is mentioned in my report. Upon later reflection I am inclined to give increased weight to this point, although the amount of such temperature stresses can only be surmised.

I wish to make it clear that all reports upon the Spokane failure are based upon examination of the wreckage while about two-thirds submerged. It is very possible that new data obtained when the steel is pulled out of the river may necessitate entirely different conclusions.

JOHN W. CUNNINGHAM.

Portland, Ore., Jan. 6, 1916.

EXTRACTS FROM ENGINEER'S REPORT TO CORONER

The positions of the different members of the fallen bridge lead me to believe that the first failure was in one of the east lower-chord sections. Since the eye-bars in the north end panel of the chord were found broken, and since the north-east end post and shoe were thrown decidedly northward and away from the bridge, while other shoes were pulled inward off the pins, it is most probable that the first failure occurred in this panel.

The total dead-load with wood-block floor, live-load of two 30-ton cars passing, with an addition for bending of the eye-bars from their own weight, gives a stress below 16,000 lb. per sq.in., which is a safe stress for good material.

While the bridge originally and also probably at the time of failure did have faults of design, it appears that the failure occurred in members which in themselves cannot be criticized on this account—eye-bar tension members.

An examination of the fractured eye-bars in the office of the City Engineer indicates a poor grade of steel. I anticipate that chemical and physical tests, such as should be made upon samples cut from these bars, will show a weak and probably a hard and brittle steel. These bars were undoubtedly inferior at the time they were placed in the bridge. The use of inferior steel could have been guarded against by proper

engineering supervision, inspection and tests at that time. Subsequent to the erection of the bridge no reasonable inspection could have disclosed their character.

I understand that crystallization has been blamed for the failure. It is my opinion, based upon some of the best authorities, that there is no change in the crystalline form of steel after it has cooled. There is, however, a progressive weakening of metal under repeated stresses, which is known as fatigue, caused by a gradual spreading of microscopic flaws and cracks when the metal is stressed close to the elastic limit. Fatigue occurs with the best grades of steel, but its effects would be most evident with a poor quality.

I have endeavored to determine why the failure occurred at this particular time. It appears to me that there was a combination of circumstances which is sufficient to explain it. The fatigue effect, as explained, was perhaps one cause. Similar cases are known of steel railroad rails, springs and automobile axles, which fail under loads less than the greatest they ever carried. However, I believe the stress in the lower-chord end panels at the time of the accident was as great as they ever had carried. The maximum stress in one member of any bridge is not necessarily caused by the greatest total load on the span; it may be caused by a particular position of the load. It is very possible that the failure occurred at the first time two cars had passed at the position giving maximum stress since the creosoted block pavement had been put on.

A third contributing circumstance is the low temperature at the time of the failure. Weather Bureau records show it to have been 16° F., the lowest this season. The end shoe of the span was of faulty design, not allowing free expansion and contraction. Under the low temperature of Dec. 18, it is probable that the shoe did not allow free contraction, resulting in an indefinite additional stress. While not in itself enough to cause failure, it may have been the last straw in this case.

Summary—I find that the most probable cause of the failure of the Division St. bridge was the breaking of the lower-chord eye-bars, due to poor material. This material was inferior at the time the bridge was built, and its use would have been improbable under proper engineering inspection. After erection, no reasonable inspection could have shown the cause of the failure. The recent addition of wood-block floor did not violate good engineering practice, and would not in itself have caused failure.

JOHN W. CUNNINGHAM,
For Baar & Cunningham.

Progress on the Canal Tunnel at Marseilles, France

Sir—In your issue of Aug. 26, 1915, following some extracts from a description of the largest tunnel in the world, by E. L. Corthell, you say:

> It is perhaps needless to say that work upon the tunnel, as on practically all other constructive engineering works in the belligerent countries of Europe, is now suspended. It is doubtful whether it will ever be resumed. The vast burden of debt due to the war will prevent European nations from embarking on the construction of any public works not absolutely necessary for a long time to come.

Unless all my sources of information are at fault, your positive and unqualified statement is directly contrary to the facts.

Prussia laid out a great program of waterway improvements in 1905. The new waterway from Berlin to Stettin was opened in May, 1914, and the enlargement of the Kiel Canal, with locks larger than those at Panama, was completed only two or three weeks before the outbreak of the war.

What Germany thinks of the improvement of waterways is shown by the fact that even while fighting for the life of the empire in the greatest war in all history, she has not only maintained and operated the waterways already completed, but has kept steadily at work building more. The great new waterway from the Oder to the Vistula was sufficiently completed to allow the passage of boats in April, 1915; and until ice put an end to navigation, it was continually in use for moving supplies and munitions toward the eastern battle-front.

Berlin, which had already spent $8,000,000 on a harbor in the eastern part of the city, has, since the war began, taken up and prosecuted work on a harbor in the western part of the city, the estimated cost of which is $9,350,000. It is worthy of note that Berlin is not on a large navigable river and is therefore investing over $17,000,000 in harbor facilities mainly to accommodate traffic on canals.

A wireless dispatch from Berlin to Sayville, N. Y., on Dec. 14, announced the completion of the Minden-Hanover waterway, which is the last link in the great Rhine-Hanover canal, which has been under construction for several years at a cost of more than $60,000,000.

I addressed a letter to Alphonse Gaulin, consul-general of the United States at Marseilles, France, asking him whether work upon the tunnel had been suspended. In his reply, he says: "I have the honor to inform you that the work on the tunnel referred to is progressing almost normally."

In your issue of Aug. 26, 1915, you say further:

> The proposition, however, to build this enormous and enormously costly tunnel, merely to save the dwindling traffic of river barges a few miles of navigation in the open Mediterranean, would appear to be a scheme absolutely quixotic from the economic point of view. Probably the tunnel will take its place with other abandoned engineering dreams.

The figures given in the "Annuaire Statistique" show that the kilometric tonnage on the section of the River Rhône from Lyon to Arles was 57,843,477 in 1904 and 67,816,523 in 1912; and on the canal from Arles to the Mediterranean it was 7,888,521 in 1904 and 11,532,351 in 1912. How long will it take at that rate of "dwindling" for the traffic to disappear entirely?

S. A. THOMPSON,
Secretary, National Rivers and Harbors Congress.
Washington, D. C., Jan. 7, 1916.

NOTES AND QUERIES

The Violet Falls Surge Tank of the Northern New York Utilities Co., described in "Engineering News," Apr. 8, 1915, p. 686, and claimed by R. D. Johnson, of New York City, to be an infringement of his surge-tank patents (see "Engineering News," May 20, 1915, p. 996) has been acknowledged by the company as an infringement, and 5% of the construction cost has been paid as royalty.

The Water Consumption of Tacoma, Wash., which was given in a Bureau of the Census press bulletin as 430 gal. per capita (see "Engineering News," Dec. 30, 1915, p. 1273) is only about half that figure, according to P. S. Savidge, superintendent of water-works at that city. The error arose from a use by the Bureau of the Census of the total amount of water conveyed to the city, of which "a considerable portion is wasted in the winter and some part in summer by overflow from the low-service reservoir."

Plate Girders 140 In. Deep—In connection with the long plate girders of the Nickel Plate at Chicago, described on page 1105, issue of Dec. 9, 1915, it is noted that the Chicago, Milwaukee & St. Paul Ry. in 1913 built a bridge to carry Earl St. over its tracks at Pelham St., St. Paul, Minn., with girders 115 ft. long. These girders are 11 ft. 8 in. deep overall and weigh 58 tons each. While not the largest girders in existence, they are probably near the record for depth.

The American Road Builders' Association—In discussing the rivalry between the two national associations in the highway-engineering field, in the issue of Dec. 30, the American Highway Association was referred to as the older organization. A correspondent writes stating that the other body, the American Road Builders' Association, is the older of the two, having been organized in 1902 under the name of the American Road Makers' Association. It was reorganized in 1910 under its present name and incorporated under the laws of New York. The American Highway Association was formed in November, 1910.

Ductile Steel for Safety

The slow but steady tendency in recent years toward specifying higher-strength and harder steel for structural work is not a movement in the direction of safety. Higher strength is likely to mean metal that is more brittle or "shorter" than the standard high-bend-test bridge steel. The ductility—we may think of it as the plasticity—of steel is a prime protection against many unknown and unknowable contingencies. Those secondary-stress actions in a structure which escape computation, and most of which are incapable of computation, are negligible only by virtue of the steel's plastic quality. With hard metal they lead to danger.

Brittle steel has produced failures. The Spokane bridge collapse, say the local engineers, was due to brittle steel. While much should yet be learned about this accident—much must yet be learned—the investigators could find nothing in the conditions of bridge and load capable of causing trouble with ductile steel. In prior cases brittle steel has been involved in structural collapses, as for instance in the fall of a large theater frame—then known as the Orpheum—in New York a few years ago. Every experience in bridge and other steel construction has told the engineer that ductile steel is safe metal and brittle steel is unsafe metal. Plates that break in the shears and I-beams that shatter to pieces when thrown from a wagon are not good structural material.

Good ductility will give a good bend-test. Higher-strength steel means progress if the gain in strength is not accompanied by decrease of bend-test qualities. But high steel with low ductility, and bend-test requirements lowered to suit the convenience of the case, lower the safety margin and thus spell retrogression

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Contrasts of the New and Old New York Canals

Scattered over the country are many readers of *Engineering News* who, as boys, watched the locking of small barges up and down the Erie and Champlain Canals in New York State. They can best appreciate the great advance in the art of canal navigation which will be demonstrated when the New York State Barge Canal is opened for traffic. All of these veterans will read with interest the description of the extensive installations of machinery required for working the new state canal, given elsewhere in this issue by the engineer who was in charge of the final development of the equipment.

These boys remember well the snap of the whip and the swish of the tow line as the patient mules toiled up to the lock flight. Not forgotten are the growls of the boatmen and the gossip of lock tenders as the little barges were coaxed into the locks, the long-handled gates shut and the leaf-valves lifted. If all the boys to whom this sight was a source of entertainment could slip back home a few years hence, what a contrast they would find!

A string of motor barges quietly slips up to the locks. A man at a little box on the lock wall turns one of several little handles before him, and with a faint rumble the lower-gate leaves swing open for the first boat to enter. A line from the first barge is slipped around an iron capstan head which begins to revolve and haul the barge into the lock. As the boat nears the upper gates, it is checked by a line to another capstan. Another turn of one of the operator's handles and the lower gates close behind the boat; a third turn and the boat slowly rises to the upper level. Still another movement at the controller and the upper gates open before the barge. During all this, if it be dusk, instead of the shouts of the lock tenders, light signals flash. A red light on the lock wall changes to green as a gate opens, and goes back to red as it closes again. As the lock valve opens, a blue light gives way to a string of white signals.

Letting natural curiosity chase away a sigh of regret for the "good old days," the wanderer looks the lock outfit over. He sees electric motors geared to the gate-leaf spars, motors lifting the lock-sluice gates, motors driving the capstans—and all fed from a little hydro-electric station in which the water of the canal is put to work. Truly typical of the contrast between the present and pioneer times are the new and the old locks on the New York Canal.

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Not an Unmixed Blessing

Public speaking unquestionably helps to make a public man. Active and pertinent discussion always adds interest to engineering-society meetings; but there may be some doubt as to the wisdom of urging discussion to the extent recommended in the following extract from a recent editorial in an engineering society's journal:

> In order to make himself better known and also to overcome his dread of getting up before a group of men and presenting his views, an engineer of this city some years ago deliberately forced himself to discuss almost every paper or lecture that was given before a certain engineering society. This man is now one of the most fluent and easy extemporaneous speakers among our successful consulting engineers.

While one cannot refrain from congratulating the engineer on his success, there is a lingering sympathy for his former associates in the engineering society.

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Keeping the Engineer's Diary

Keeping a daily record of construction progress is a familiar and integral part of the resident engineer's duties. The method of doing this is by no means standardized, but the general scheme is to write up a report at the end of each day. J. C. L. Fish, in another part of this issue, believes he has a better way. His diary is divided into two elements—notes made in the field, and those which can just as well be written up in the office. A distinctive feature of the office diary is that it is not the work of one man, but of the entire party. Each man writes in the book the important items in his day's experience.

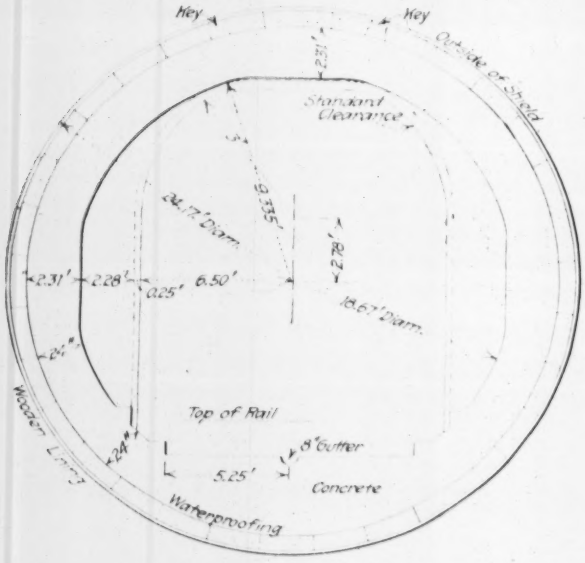
Entries are made in the field diary on the spot instead of trusting to the memory of a fatigued man. Such entries naturally will be more numerous and detailed, and more reliable and useful. Making entries on the spot has another valuable tendency—it should make the engineer's inspection more thorough.

One fault of the usual diary is that all the elements of a job are jumbled together. Under the proposed system the several items of construction are kept on separate sheets, so that when these sheets are brought together chronologically they form a complete history of the particular bridge, culvert, tunnel or contract section.

Lining a Shield-Driven Tunnel with Wood and Concrete

Tunnels driven with steel shields forced forward by hydraulic jacks and lined with cast iron are necessarily very costly on account of the great weight of cast iron required. It is not possible to reduce the weight of the cast-iron lining by any material reduction in its thickness or in the depth of the stiffening ribs, for at best the cast-iron lining is lacking in stiffness to resist forces which may tend to deform the tunnel ring, and the lining as soon as placed has to withstand the enormous thrust of the hydraulic jacks that drive the shield forward.

Many schemes have been suggested and some have been tried for lining shield-driven tunnels with concrete. A necessary feature of any such scheme is provision for taking the thrust of the jacks, and at the same time of building a continuous lining under the tail of the shield, so that entry of mud and water at this point may be prevented.



CROSS-SECTION OF DORCHESTER TUNNEL UNDER FORT POINT CHANNEL, BOSTON SUBWAY SYSTEM

In the extension to South Boston of the Boston Rapid Transit subway system, known as the Dorchester subway, now under construction, a tunnel is being driven from a connection with the present subway system at South Station longitudinally under Fort Point Channel. A continuous wooden lagging instead of cast iron has been adopted for lining this tunnel. Inside this wooden lining a concrete lining is placed.

The tunnel is being built by the Boston Transit Commission, of which E. S. Davis is Chief Engineer. G. D. Emerson is the Division Engineer in charge of this work. The contractors for the tunnel are P. McGovern & Co.

The ground through which the tunnel is now being driven is a rather stiff clay, with approximately 15 ft. of cover between the tunnel roof and the river bottom. Compressed air of about 15 lb. pressure is used. The wooden lagging blocks are of yellow pine and are sawed to uniform dimensions of 4 ft. 8 in. long, 9 in. in depth radially and 9¾ in. thickness. The blocks are furnished sawed to dimensions, ready for placing, by the firm of Geo. M. Questen & Co., which installed special machinery for sawing the blocks to the proper curve and beveling the ends to the proper angle to make a tight joint with the adjacent blocks as the tunnel ring is built up.

The sixteen segments and key-piece which make up each ring are so laid as to break joints with the blocks in the ring preceding. In order to secure the successive rings to each other, each block is bored near each end with three holes in which are inserted pins cut from ½-in. round steel with the ends swedged to a dull point. These pins are inserted in the holes before the block is placed and are long enough so that when the jack-pressure is brought to bear on the block the sharpened ends of the pins are driven into the segments of the previous ring.

These wooden blocks are much lighter to handle than the cast-iron segments commonly used in shield tunneling, so that the usual segment-placing jack is unnecessary, and they make a lining more nearly water-tight. There is of course no question as to their permanence in the saturated ground where they are placed.

To give additional security against possible leakage, the wooden lining after laying is covered with waterproofing made up of several layers of felt saturated with hot asphalt. On this as a backing, a 2-ft. concrete lining is placed. The concreting is done in rings of about 15 ft. width in Blaw collapsible steel forms. The concrete is mixed at the tunnel shaft and is brought in through the air lock in small cars hauled by electric locomotives.

When the work was visited by one of the editors of *Engineering News*, no seepage whatever into the tunnel was discernible. It is stated that the tunnel lining above described effects a saving of about 20% as compared with the ordinary cast-iron lining.

Carrying Clay on a Belt Conveyor

In ordinary shield tunneling work, the muck excavated by the workmen inside the shield is thrown to the floor of the tunnel just back of the shield and then shoveled into cars for hauling away. With the construction above described it was desired to dispense with the gang of muckers in the rear of the shield, as the point where they would be working was just the point where the gang applying the waterproofing to the wooden lining needed to work. It will be obvious also that the waterproofing can be better applied to the wooden lining before it is covered with wet clay. The contractor also desired to maintain his rate of progress and enable the mucking always to keep pace with the excavators in the shield.

To accomplish these ends, the contractor has installed a special slow-speed belt conveyor in the tunnel. This conveyor receives the clay excavated by the muckers in the shield and transports it about 70 ft. to the rear, where it is discharged into the dump cars, which after loading are hauled through the air lock, hoisted up the tunnel shaft and then pushed by a dummy engine onto an elevated pier alongside the Fort Point Channel, where they are dumped into scows. Predictions were freely made that a belt conveyor would not work in transporting wet clay, on account of the sticky character of the clay. A very slight sprinkling of water on the belt, however, is found to prevent the clay from sticking to it.

The apparatus used is very simple in character, as befits the place where it has to work. The shield has three working platforms, and the excavators on each of

platforms throw the material into a hopper the mouth of which is about on a level with their feet. From the bottom of each hopper the clay drops onto the belt, the mouth of the hopper being close enough to the belt that a large load cannot be applied to the belt at one point.

The muck cars are handled by an electric locomotive, which spots the cars under the discharging switch from the conveyor as required.

While other considerations, as stated above, were the controlling ones in bringing about the installation of the belt conveyor, the amount of labor it saves, with the increased speed of excavation, makes it a profitable tool for the contractor.

Grenville M. Dodge

Maj.-Gen. Grenville Mellen Dodge, famous as the Chief Engineer who had charge of the construction of the Union Pacific R.R., the first transcontinental railway, died on Jan. 3 at his home in Council Bluffs, Iowa, in his eighty-fifth year.

He was born Apr. 12, 1831, at Danvers, Mass. He was a country boy and his early schooling was intermittent. However, he prepared for Norwich University, a famous Vermont military school, where he was graduated in 1850. He then entered Captain Partridge's private school of civil engineering, from which he was graduated in 1851.

The Middle West at that time offered many opportunities to young engineers, and it was not long before he had joined two of his classmates at Peru, Ill., where all three were employed by George W. Gilson in general land surveying. After a few months he had an opportunity to join the engineer corps of the Illinois Central R.R. as an axman. Six months later he was employed as a rodman by Peter A. Dey, then Division Engineer of the Rock Island R.R. (See *Engineering News*, Aug. 31, 1911, for biography of Mr. Dey.)

In the spring of 1855 Mr. Dey was appointed Chief Engineer of the Mississippi & Missouri R.R., and Mr. Dodge became assistant engineer in charge of the location surveys from Davenport to Iowa City. The following year the surveys were extended to Council Bluffs, which was to be the terminus of the Mississippi & Missouri R.R. Here he settled with his family in 1854.

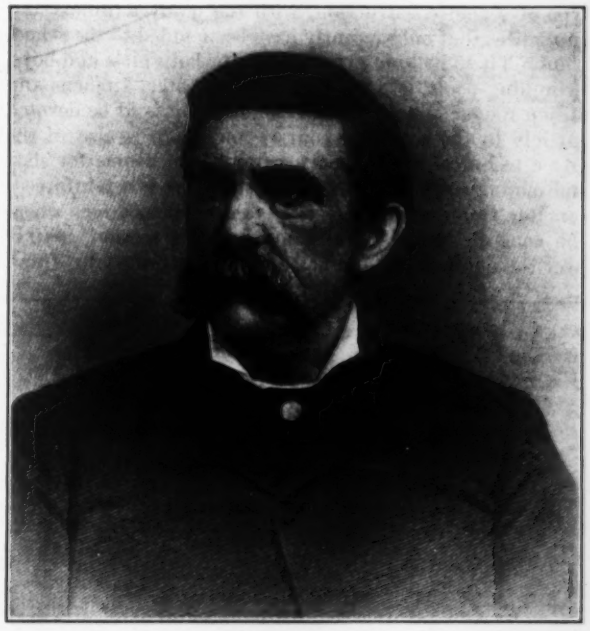
For several years and until the outbreak of the Civil War he was engaged in the mercantile business and in freighting on the plains. He sent the first wagon train through to Denver and opened there on Cherry Creek one of the settlement's first trading depots. In the meantime he continued his interest in railway promotion and was at various times engaged in reconnoissances and surveys west of the Missouri River.

At the outbreak of the Civil War he volunteered his services to the Government and became one of its most prominent and useful engineer officers. In 1862 he was placed in command of the central division of the Mississippi and had an active part in the campaign which won the Mississippi Valley. Subsequently he took part in Sherman's campaign against Atlanta, after which he was assigned to the command of the Department and Army of Missouri. He was here, in 1865, offered the position of Chief Engineer of the Union Pacific R.R., from which his former chief, Mr. Dey, had resigned; but because of Indian disturbances on the Western plains General Grant was unwilling to spare him from the army. However, on May 1, 1866, he obtained leave of absence and went to Omaha to take up his new work.

Ground for the first transcontinental railway had been broken at Omaha on Dec. 1, 1863, and in 1864 a few miles of roadbed were graded. When General Dodge took charge, track had been laid for 40 mi. west of the Missouri River. The rate of construction work was rapidly increased, and on May 10, 1869, the last rail was laid at Promontory Point, Utah, completing the connection with the Central Pacific R.R. Many interesting incidents in connection with this great work as well as many Civil War reminiscences may be found told in General Dodge's own words in *Engineering News*, Oct. 28, 1909.

During the last years of the building of the Union Pacific R.R. General Dodge engaged in surveys for other Western railways, including the Oregon Short Line from Salt Lake City to Portland, Ore., the Chicago & Northwestern R.R. and connecting lines for the Union Pacific. He resigned as Chief Engineer of the Union Pacific in 1870 and became Chief Engineer of the California & Texas Construction Co., which was then engaged in building a railway from Shreveport, La., to San Diego, Calif., a large part of which is now in the Southern Pacific system. He also had charge of building the Texas Pacific.

In 1880 General Dodge organized and became president of the American Railway Improvement Co. and had charge of the building of the New Orleans & Pacific



G. M. Dodge

R.R., the Missouri, Kansas & Texas R.R., and the International Ry. of Texas. He was also president of the Colorado Railroad Construction Co., organized to build the Fort Worth & Denver City Ry., and of the Oriental Construction Co. for the construction of railways in Mexico. In 1882 he was made vice-president of the Mexican &

Southern R.R., of which Gen. U. S. Grant was president. He succeeded General Grant as president of that road in 1885 and supervised the survey of the line from the City of Mexico through the State of Oaxaca to the Pacific Ocean. Subsequently he had charge of surveys for the Cheyenne & Northern R.R. and of the building of the Des Moines Northern R.R. He was president of the Panhandle Construction Co. and of the Colorado & Texas Railway Construction Co.

Besides the prominent part he took in the promotion and organization of many Western railways, General Dodge was a leading figure in politics. He took an active part in all the presidential elections from 1861 to 1908 and was a delegate from Iowa to the Republican National Conventions of 1868, 1872 and 1876. From 1867 to 1869 he was a member of Congress from Iowa. He declined a renomination in order to devote all his energies to the construction of the Union Pacific.

He was married, May 29, 1854, at Salem, Mass., to Miss Annie Brown, of Peru, Ill., who with three daughters survives him.

Concrete Stadium a Part of a High School Building

The Central High School building now under construction in Washington, D. C., occupies about four city blocks, extending from 11th St. to 13th St. and from Florida Ave. to Clifton St. The building proper is of the most modern type of school construction, with the many adjuncts and appliances that only recently have been added to the school plant. These include gymnasiums for both girls and boys, swimming pools, a large auditorium theater, kitchens and dining rooms, and (although the building is to be devoted entirely to the academic courses and there is also in the city a technical high school) a number of rooms for shop and manual-training work. The structure is a reinforced-concrete frame with some steel framing at locations where the concrete would require too heavy a section, mainly over the auditorium, and has a brick and stone trim front.

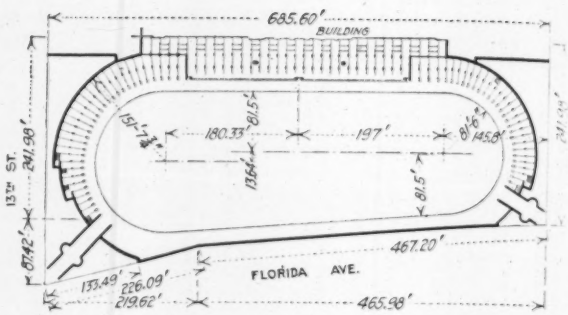


FIG. 1. PLAN OF STADIUM AT CENTRAL HIGH SCHOOL, WASHINGTON, D. C.

In connection with the building there is a unique feature in the way of a large reinforced-concrete stadium immediately adjoining the building and inclosing a playing field which embraces space for football and baseball fields and for a drill ground for the cadets, as well as a quarter-mile outdoor running track. This stadium will have seats for 6,000 persons. The building site is on a rather steep hill, with the building at the upper half of the lot. Consequently the stadium could be built at the lower half and so arranged that the upper platform and promenade of the stadium would be at the same level as the second-story floor of the building; this promenade in fact forms a balcony at this floor of the building. Fig. 1 is a plan of the stadium. As will be noted there, it covers a plot of ground 686 ft. long, 329 ft. wide at one end and 242 ft. wide at the other, and the stadium structure incloses about three sides of this area. The fourth side, which is on Florida Ave., is about 10 ft. higher than the sidewalk at that street, and the ground is held by a concrete retaining wall that also forms a parapet on the lower side of the playing field. Fig. 2 is a view looking over the field toward the stadium and the building during its construction.

As will be noted in Fig. 3, the general design of the stadium comprises reinforced-concrete columns carrying girders which are inclined for the step portion and which are

FIG. 2. LOOKING OVER THE PLAYING FIELD TOWARD STADIUM AND SCHOOL BUILDING

horizontal in the promenade portion of the structure. These columns in turn are spanned by reinforced-concrete steps, in the risers of which are embedded staples into which chairs can be fitted. In the corridors, intermediate steps with risers of 8 in. and treads of 9½ in. are inserted.

Along the building front, the horizontal promenade part of the stadium forms a roof to a corridor opening into the basement of the building, which is used as an indoor running track. On this account the promenade is provided with glass panels, and the risers in the upper part of the stadium are similarly opened, in order to light the track. The main columns at this location are founded on the retaining wall that holds back the earth of the running track, as shown in the section in Fig. 3. Here also the inclined beams overhang the lower column, as shown in Fig. 3, in order to provide a roofed pit where the contestants at games may sit. In the remainder of the stadium, however, the lower column is immediately under the lower railing of the stadium.

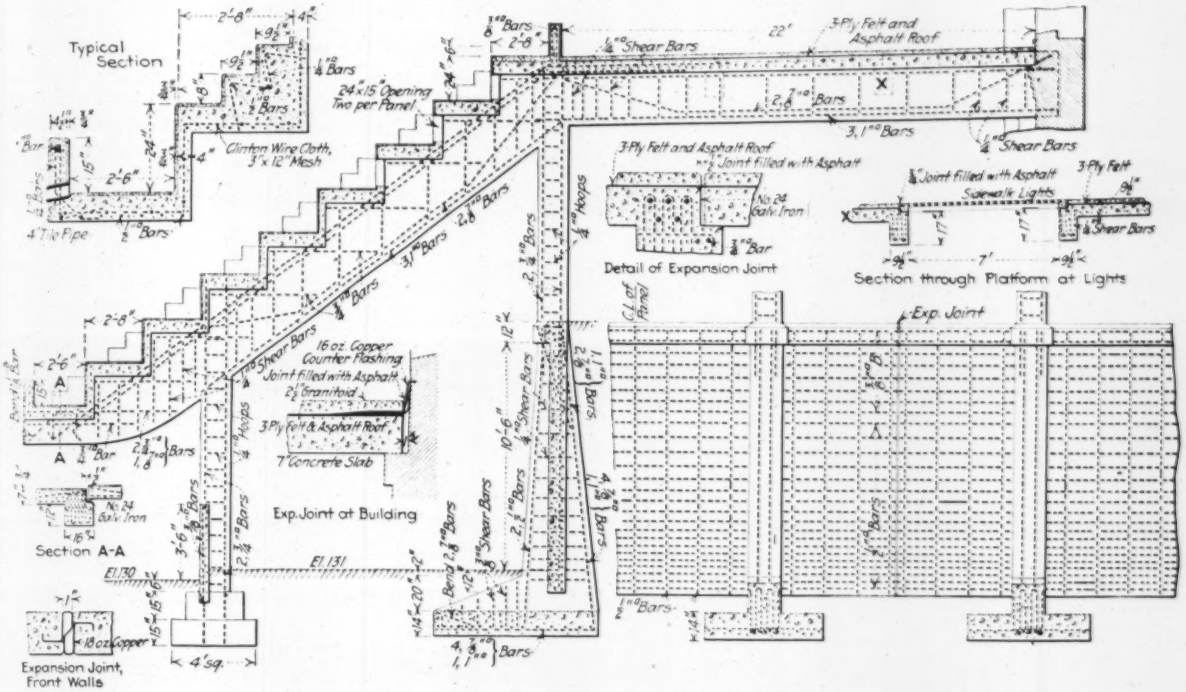


FIG. 3. DETAILS OF STADIUM ON SIDE WHERE IT CONNECTS WITH BUILDING

The structure is entered by two inclines at the lower corners of the lot and by one or two staircases leading down to the ground behind the stadium. There are no staircases through the stadium proper, as is common in similar structures.

Expansion is provided, according to the detail shown in Fig. 3, between the columns and where the promenade floor joins the building and along the steel balcony wall. That detail at the field balcony wall is particularly novel, involving as it does the double-turned copper plate shown.

The concrete work of both building and stadium was carried out practically entirely from one plant on 13th St. This plant was so located that wagons with material could drive in from the street and dump the material into hoppers above the mixer. The mixed concrete was delivered to hoppers elevated to the tower shown at the left of the view, Fig. 2, whence it was spouted to all parts of the work with the exception of some of the stadium at the 11th St. corner, which was too far away to be reached by the spouts. The spouts were carried on cableways suspended from another tower that was moved from place to place on the work as required. These towers were both 170 ft. high. With them over 35,000 cu.yd. of concrete was deposited.

Somewhat novel provisions were included in the concrete specifications. Instead of specifying a 1:2:4 or 1:2½:5 mixture, the specifications were that the volume of sand should equal 50% of the volume of aggregate, and the cement should be in such quantity that every 6½ cu.ft. of concrete in place should contain not less than 94½ lb. of cement. The concrete was tested every so often and the mix made to fit the test according to the specifications. It amounted to about a little leaner than a 1:2:4 mixture and was used in all the foundation work. For the reinforced-concrete work the same specifications prevailed, except that instead of the cement equaling 6½ cu.ft. the specification read that the "volume of sand shall be 50% of the volume of aggregate, and the cement shall be such that every 4½ cu.ft. of concrete in place will contain not less than 94½ lb. of cement." This mixture was somewhat richer than a 1:2:4.

The site, as stated above, was on a very steep hill, and a great amount of steam-shovel grading was required before the concrete was to be started; about 100,000 cu.yd. of excavation was made.

The new Central High School building is being built by the District of Columbia, under the general direction of Snowden Ashford, Municipal Architect, and Wm. B. Ittner, of St. Louis, Mo., as consulting architect. The concrete work is being done by the Hammett Fireproofing Co., of Washington, D. C., of which company R. G. Fletcher is General Superintendent.

News of the Engineering World

Another East River Tunnel

A tunnel under the East River for the rapid-transit subway system was put under contract by the New York City Public Service Commission on Jan. 13, the successful bidders being Booth & Flinn, Ltd. The contract price is $6,639,000, and the contract time of completion is 27 months. The tunnel is to extend from East 14th St. in the Borough of Manhattan to North 7th St. in the Borough of Brooklyn. This location is about a mile north of the Williamsburg bridge over the river and about a mile south of the Pennsylvania R.R. tunnels under the river. Some delay has occurred in the award of the contract through the efforts of D. D. McBean and associates to have the commission adopt the plan of tunnel construction which Mr. McBean invented and which was used in the construction of one of the Harlem River tunnels for the rapid-transit system in 1903.

As many of the readers of *Engineering News* will recall, the McBean system consists in dredging a trench in the bottom of the river, driving in the trench two lines of sheet piling, and sinking a timber roof on top of the piling, the whole forming a caisson in which the tunnel structure is built. An advantage claimed by Mr. McBean for his system is that it is possible by it to bring the roof of the tunnel closer to the river bottom than can safely be done with tunnels driven by the shield system, which is the plan of construction contemplated in the commission's plans and to be used by Booth & Flinn.

Besides the obstruction to navigation which would occur during the construction of the tunnel under the McBean system, it was found that in view of future possible deepening of the East River, to enable the largest-sized battleships to reach the Brooklyn Navy Yard at all stages of the tide, it would be necessary to dredge the trench for the McBean system to a depth as great as 90 ft. below the water surface. In the Harlem River the depth of the trench was not over 50 ft. Under these conditions it was felt that there would be no advantage in the McBean system.

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Grade-Crossing Elimination on West Side of Manhattan

The freight line of the New York Central R.R. along the west side of New York City is to be reconstructed so as to eliminate grade crossings practically throughout the whole length from the northern boundary of the city to the southern end near Canal St. Plans have been worked out by the railroad in the course of several years past, and recently in conference with city officials an agreement was reached on the substantial points of the improvement. The work, including electric-traction equipment, is estimated to cost nearly $50,000,000. The city will donate some land needed for the improvement but will pay no money.

Tunnel, or covered subway, will be built along Inwood Hill just south of Spuyten Duyvil from the Harlem Ship Canal at the north end of Manhattan Island south to Dyckman St., for four tracks, and through Fort Washington Park; along upper Riverside Park from 153rd to 135th St. will be a yard and six running tracks; and along lower Riverside Park from 128th St. to 72nd St., six tracks fanning out to the yards below 72nd St.

Elevated structure will be employed at the crossing of Dyckman St., at Manhattan St. and on the entire yard and trackage system south of 59th St. A four-track elevated structure is to run along 12th Ave. and Marginal St. to the entrance of the 30th St. yard at 38th St. South of the yard a two-track elevated railway is to be built on private right-of-way just east of West St., as far south as Canal St.

The present agreement is the outcome of vigorous agitation carried on for many years against the New York Central's occupancy of 11th Ave., 10th Ave. and connecting streets with its freight trains, a condition of great danger to life and interference with traffic. In part also it results from the efforts of the Riverside Park region residents to do away with smoke and noise from locomotives on the tracks alongside the park. The scheme as adopted is probably as much æsthetic improvement as traffic improvement.

An important feature provided for future development in this scheme is the possibility of a connecting cross-town tunnel or subway near 57th St. eastward to Grand Central Terminal, which would permit New York Central passenger trains to be run into the city over the west-side line instead of over the Harlem R.R. and through the Park Ave. tunnel. The capacity of the tunnel and the Harlem R.R. line, whose four tracks must carry between Grand Central Terminal and Mott Haven all traffic of the New York Central and New York, New Haven & Hartford lines, has long been inadequate, and no increase of capacity is possible except by a scheme such as the west-side diversion contemplated for future construction.

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Seattle Wood Water Pipe Fails

Breaks in one of the wood-stave supply mains of Seattle, Wash., while the second and older conduit was out of commission for repairs, cut off the water-supply of parts of the city for several days, beginning on the night of Jan. 7-8. An emergency supply was provided by conveying water in tank cars to barrels distributed throughout the dry section. Leaks in the conduit in service were reported and repaired on Jan. 7. After the water was turned into the conduit, a section 150 to 200 ft. long collapsed, possibly due to undermining from the leaks. By working almost continuously for 48 hr. the conduit was restored to service about 7:30 p.m., but about three hours later some 75 ft. more of conduit failed a half mile lower down. This was repaired and water service at last restored in about 24 hr. The repairs were made under the direction of L. B. Youngs, superintend-

of water-works. On Nov. 19, 1911, both of these wood-stave supply conduits were put out of service by a flood which washed out a bridge supporting them and did other damage. (See *Engineering News*, Dec. 14, 1911, for an account of the flood, the damage it wrought and emergency-repair methods.) After that flood the Fire Underwriters Association renewed its recommendations of 1906 for a salt-water high-pressure fire-protection system. Later, A. H. Dimock, city engineer, advised a fresh-water system instead, utilizing an existing pumping station on Lake Washington (building a new station at the foot of Lake Union and reinforcing the water mains at various points). Some of the larger mains recommended have been put in, and the Lake Washington station has been kept available. During the last three years Messrs. Dimock and Youngs have recommended the construction of additional reservoirs for the sections deprived of water on Jan. 8 to 10. Since the recent accident, there has been much talk of the imperative need for a third supply conduit, to be built of concrete.

F. R. Harris, Chief of Bureau of Yards and Docks

Frederick R. Harris, of the Corps of Civil Engineers, U. S. N., has been appointed and confirmed as chief of the Bureau of Yards and Docks of the Navy Department, with the rank of rear-admiral. He succeeds H. R. Stanford, Corps of Civil Engineers, U. S. N., who has just completed his four-year term as chief of the bureau.

Mr. Harris was born in New York City in 1875 and graduated with the degree of mechanical engineer from Stevens Institute in 1896. He entered the Corps of Civil Engineers in 1903 and since that time has served successively at Charleston, S. C., Guantanamo, Cuba, Washington, D. C., Brooklyn, N. Y., and Philadelphia, Penn. At Brooklyn he had charge of the difficult construction of dry dock No. 3

A Luncheon in Honor of Henry W. Hodge, recently appointed a member of the Public Service Commission of New York City, was given at the Railroad Club in New York City on Jan. 12 and was attended by 40 of the leading engineers in New York, while many unable to be present sent regrets. William J. Wilgus acted as toastmaster, and brief speeches were made by a number of those present, the keynote of the speeches being the service rendered to the profession and to the public by Mr. Hodge in accepting the office, and the value to the public in having in positions of such responsibility engineers who understand the technical matters with which the commission has to deal and who possess the necessary executive ability and personal qualifications for success in the work.

Elevated-Railway Third Track in Service—The new express-track system of the elevated railways in Manhattan and Bronx Boroughs, New York, was put into operation on Monday, Jan. 17, 1916. Construction was practically completed a month or two since. The new trackage, as described in "Engineering News," Sept. 30, 1915, p. 625, affects three of the four lines: Ninth Ave., Third Ave. and Second Ave. The middle or express-train track heretofore existing on the Ninth Ave. line from 116th St. south to 14th St. has been extended south about 3 mi. to Rector St. and north 2 mi. to 157th St., and both old and new portions provided with intermediate stations, the longest station interval now being from 66th to 116th St. (instead of 14th to 116th). The Third Ave. line, which had a short length of middle track, has been third-tracked for the full length from City Hall to Bronx Park, and the Second Ave. line from Chatham Square to the Harlem River bridge. The old double-track bridge was replaced by a four-track structure ("Engineering News," Sept. 2, 1915, p. 437). The system as now operated should develop a rush-hour capacity some 25% greater than it had as previously operated and should relieve the load on the subway.

PERSONALS

Mr. C. R. Sumner has been appointed City Engineer of Hermosa Beach, Calif.

Mr. C. M. James, Assistant to the Third Vice-President of the Atlantic Coast Line R.R., at Wilmington, Del., has been appointed Engineer of Construction of that railroad.

Mr. John H. Hanna, M. Am. Soc. C. E., formerly Chief Engineer of the Capital Traction Co., of Washington, D. C., has been elected Vice-President in charge of the operations of the company.

Mr. Guy A. Rupp, formerly in the Maintenance-of-Way Department of the Lehigh Valley R.R., has been appointed Constructing Engineer of the Pennsylvania Trojan Powder Co., at Allentown, Penn.

Mr. H. C. May, Superintendent of Motive Power of the Chicago, Indianapolis & Louisville Ry., has been appointed to a similar position on the Lehigh Valley R.R., with headquarters at South Bethlehem, Penn.

Mr. E. B. Hillegass, Assistant Engineer of the Atlantic Coast Line R.R., at Rocky Mount, N. C., has been appointed Engineer of Roadway, with headquarters at Savannah, Ga. He succeeds Mr. C. J. Chenworth.

Mr. E. Owen McCann, head of the Engineering Department of St. Ignatius University, San Francisco, Calif., has opened offices as Consulting Mining and Civil Engineer in the Mills Building, San Francisco.

Mr. Kenneth B. Ward, of Painesville, Ohio, has been elected City Manager of Sandusky, Ohio, by the Board of Commissioners of that city, at an annual saluary of $3,600. Mr. Ward is a graduate of Ohio State University.

Maj. George B. Pillsbury, M. Am. Soc. C. E., Corps of Engineers, U. S. A., New London, Conn., will be transferred to succeed Maj. R. R. Raymond at Los Angeles, Calif. Major Raymond will leave for Honolulu on Feb. 1.

Mr. Claude L. Van Auken, formerly of the Valuation Department of the Chicago, Milwaukee & St. Paul Ry., has been appointed Assistant Engineer on the valuation of Chicago Terminals for the Chicago, Rock Island & Pacific Ry.

Mr. Collingwood Schreiber, Hon. M. Can. Soc. C. E., Consulting Engineer to the Canadian Government and a noted authority on railroad engineering, has received from King George of England the title of Knight Commander of the Order of St. Michael and St. George.

Capt. George H. Norton, Deputy Engineer Commissioner of the Department of Public Works of Buffalo, N. Y., has been elected City Engineer of that city. Captain Norton is a graduate of Cornell University. He entered the service of the city in 1898 as Assistant Engineer.

Mr. Harland Bartholomew, who recently resigned as Secretary of the Newark, N. J., City Planning Commission, is now Engineer of the Citizens' City Plan Committee of St. Louis, Mo., an unofficial organization which will coöperate with the City Plan Commission in solving certain traffic problems.

Mr. H. B. Greene, Superintendent of the Wheeling division of the Baltimore & Ohio R.R., at Wheeling, W. Va., has been appointed Superintendent of the Cleveland division, to succeed Mr. W. T. Lechlider, who recently resigned. Mr. Greene will assume his new duties Feb. 1, with headquarters in Cleveland.

Messrs. Isham Randolph, M. Am. Soc. C. E., and George F. Stickney, M. Am. Soc. C. E., have been engaged by the Lake Erie & Ohio River Canal Board to report upon the project of the board, now under way. Mr. George M. Lehman, M. Am. Soc. C. E., Chief Engineer of the board, will act with them in completing the report.

Mr. R. B. Miller, former Traffic Manager of the Oregon-Washington Railway and Navigation Co., has resigned to accept a position with Twohy Bros., railroad contractors, Portland and San Francisco. He is to be connected, it is understood, with the construction of the California & Oregon Coast R.R. from Grant's Pass toward Crescent City, Calif.

Mr. David H. Goodwillie, Assoc. M. Am. Soc. C. E., former Superintendent of Water-Works of Toledo, Ohio, has been appointed Director of Service of that city by Mayor-Elect Milroy. Mr. Goodwillie is a graduate of Cornell University. For some time before going to Toledo, in 1909, he was engaged by the United States Steel Corporation to introduce and install filter plants.

Mr. I. J. Stander, who was connected with the Department of Docks and Ferries of New York City for 16 yr., has or-

ganized the firm of I. J. Stander & Co., Inc., with offices at 118 East 28th St., New York City, to conduct a general engineering and contracting business, with special reference to the construction of bulkhead walls, piers, docks and submarine and heavy foundation work.

Mr. William A. Baehr, of Chicago, consulting electrical engineer, has been named by the Merchants Power Co., of Memphis, Tenn., as its arbitrator in ascertaining the value of the plant, transmission lines, etc., which are to be taken over by the city. The commissioners of the city will select another, and a third is to be selected by these two. A bond issue of $1,500,000 has been voted for the purchase.

Messrs. Tudor R. Williams and Rex D. Richardson, Assoc. M. Am. Soc. C. E., announce the dissolution of their partnership under the firm name of Williams & Richardson, 828 Connell Building, Scranton, Penn. Mr. Richardson will carry on a general contracting and engineering business, specializing in the design and construction of reinforced concrete, at the same address, under the name of the R. D. Richardson Construction Co.

Mr. E. F. Walker, formerly Manager of the Water-Works Department of the International Steam Pump Co., and recently Eastern Representative of John H. McGowan Co., is now representative in eastern New York, New Jersey and the New England States of the National Transit Pump and Machine Co., of Oil City, Penn., with headquarters at 30 Church St., New York City. The National Transit Pump and Machine Co. was a former subsidiary of the Standard Oil Co.

Mr. Ervin G. Bailey, M. Am. Soc. M. E., Mechanical Engineer of the Fuel Testing Co., Boston, Mass., will hereafter devote his entire time to the newly organized Bailey Meter Co., which has been incorporated to manufacture and sell a most complete line of recording meters and instruments for power-plant and other similar uses. The Bailey meters have been developed during the past six years in the mechanical-engineering department of the Fuel Testing Co., to which concern Mr. W. B. Calkins, Mr. Bailey's partner since that company was organized, will continue to give his personal direction.

Mr. F. W. Ballard, Assoc. Am. Inst. E. E., former Commissioner and Engineer of the Light and Heat Division of the City of Cleveland, has opened offices at 811 Swetland Building, in that city, for the general practice of engineering and architecture, giving particular attention to the design of light and power plants, industrial buildings and factory buildings of all kinds, and to appraisal of public utilities and industrial properties. Mr. Roy Husselman, Chief Draftsman and Construction Engineer of the Municipal Electric Light Plant, will be associated with him. The name of the new firm will be F. W. Ballard & Co.

Mr. William H. Yates, M. Am. Soc. C. E., author of the article "How the New York State Barge Canal Will Be Operated," in this issue of "Engineering News," was graduated from Columbia University in 1903 and was Instructor in Civil Engineering at that institution from 1903 to 1907. From the latter year until 1911 he was Assistant Engineer, Headquarters Department, New York City Board of Water Supply. From 1911 to 1915 he was Supervising Engineer, Office of State Engineer and Surveyor, at Albany. Since March, 1915, he has been engaged in independent practice in New York City, with office at 52 Wall St.

Mr. T. Houston Johnston, of Atlanta, Ga., has been elected engineer to the Western & Atlantic R.R. re-leasing commission, a body elected by the Georgia legislature to handle the question of re-leasing this road, which is owned by the state and at present leased to the Nashville, Chattanooga & St. Louis Ry. Mr. Johnston has been special valuation engineer of the Federal Government. He will work with the Interstate Commerce Commission engineers who are revaluing the road and will check their results. The commission, under powers granted it by the legislature at a special session, is considering the extension of the road to the seaboard.

Mr. John Meigs, M. Am. Soc. C. E., lately director of the Department of Wharves, Docks and Ferries of the City of Philadelphia, and previously for 15 yr. in charge of engineering design and construction work of varied character, has opened offices at 614 Pennsylvania Building, Philadelphia, to conduct a general consulting and constructing engineering practice. He will give special attention to the investigation, valuation, design, construction and operation of public and private engineering works and industrial plants, including general river, harbor and port improvements, foundations, bridges, buildings, power plants, water-supply, sewerage and pavements.

Mr. A. M. Nelson, M. Am. Soc. C. E., was elected Tennessee State Highway Engineer by the State Highway Commission on Jan. 11, his appointment taking effect immediately. Mr. Nelson is a graduate of Washington and Lee University. He was Assistant Engineer of Valuation of the Oregon Short Line R.R. and was in charge of highway construction in Utah, Idaho and other western states under the auspices of the railroad company. Mr. Nelson will hold three conferences on road officials—at Knoxville, Feb. 15 to 18; Nashville, Feb. 22 to 25; and Jackson, Feb. 29 to Mar. 3. The engineering department of the University of Tennessee will aid in conducting these conferences.

Mr. David S. Carll, M. Am. Soc. C. E., has retired from the office of General Manager of the Capital Traction Co., of Washington, D. C., retaining his position as Vice-President and member of the Board of Directors of that company. Mr. Carll was born in 1855. His first important position was Assistant Engineer on location work on the Long Island R.R., between Patchogue and Eastport. He was also Assistant Engineer in charge of the construction of 8 mi. of the New York, West Shore & Buffalo Ry., in Ulster County, New York. From 1884 to 1886 he was leveler and transitman in the employ of New York City. In 1887-88 he was assistant engineer on the construction of cable-car lines in Kansas City, Mo. In 1900 he served as resident engineer on the installation of cable lines for the Washington & Georgetown Railroad Co. From September, 1892, to March, 1908, he was Chief Engineer of the Capital Traction Co., in the latter year being made Second Vice-President and General Manager of the company. Appreciation of Mr. Carll and an estimate of his worth and service were expressed by the Board of Directors in a resolution adopted on Jan. 12. The active direction of the engineering of the company will be taken over by Mr. John H. Hanna, as noted on the preceding page.

OBITUARY

Loren Edward Hunt, Assoc. M. Am. Soc. C. E., Chief Assistant City Engineer of San Francisco, died recently at his home in that city. He was born in Austin, Minn., 46 years ago and was a graduate of the University of California. He was at one time an instructor in the civil-engineering department of the university and served in the United States Forest Service previous to his connection with the City of San Francisco.

Adolphe Greiner, a prominent international figure in steel circles, died at Seraing, near Liege, Belgium, on Nov. 20, 1915, at the age of 72. For many years he had been connected with the John Cockerill Co., of that place, and for 28 years before his death had been general director. He was a member of the International Association for Testing Materials and the congress member for Belgium. He was also chairman of the Iron and Steel Committee of that association.

William W. Follett, M. Am. Soc. C. E., a well-known consulting engineer in the Southwest, died at his home in El Paso Tex., Dec. 30, at 58 years of age. He was born in New Sharon, Me., and was a graduate of the University of Michigan, which in 1914 conferred upon him the honorary degree of Master of Engineering. Mr. Follett went to El Paso in 1889 to act as consulting engineer for the United States Geological Survey, which was then conducting investigations of the international dam proposed for the Rio Grande in that vicinity. He was later appointed consulting engineer of the American section of the International Boundary Commission, on which he served for 16 years. During that period he became recognized as an authority on water-boundary matters and was said to know the Rio Grande River better than any other man. He acted also at one time as consulting engineer of the El Paso & Southwestern System in planning the water-supply for the system from the White Mountains of New Mexico.

Oliver G. Gayley, First Vice-President of the Pressed Steel Car Co., Pittsburgh, and Vice-President of the Western Steel Car and Foundry Co., Chicago, died at his home in New York City, Jan. 9, at 56 years of age. He was born in West Nottingham, Md., and educated at the West Nottingham Academy and the Franklin Institute, in Philadelphia. After finishing his education Mr. Gayley entered the service of the Pennsylvania R.R. as a civil engineer. Eight years later he became Division Engineer on the Philadelphia & Reading Ry. and was subsequently an operating official of the St. Louis Car Wheel Co. and General Manager of the Safety Car Lighting and Heating Co., of which he was a director at the time of his death. Mr. Gayley's first position with the Pressed Steel Car Co. was that of General Manager of Sales, from which he rose to that of First Vice-President. He was also a director of the Chicago & Calumet River R.R.

ENGINEERING SOCIETIES

COMING MEETINGS

ILLINOIS CHAPTER: AMERICAN WATER-WORKS ASSOCIATION.
Jan. 25-27. Annual meeting, University of Illinois, Urbana. Secy., Dr. Edward Bartow, Urbana, Ill.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 26-28. Annual meeting, University of Illinois, Urbana, Ill. Secy., E. E. R. Tratman, Wheaton, Ill.

WISCONSIN HIGHWAY COMMISSIONERS' ASSOCIATION.
Jan. 31. Annual meeting in Madison. Secy., G. H. Mainwaring, Gotham, Wis.

WISCONSIN ENGINEERING SOCIETY.
Feb. 2. Annual meeting, Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 2-5. Annual meeting in Indianapolis. Asst. Secy., W. F. King, Indianapolis, Ind.

INDIANA ENGINEERING SOCIETY.
Feb. 3-5. Annual meeting in Indianapolis. Secy., Charles Brossmann, 1616 Merchants Bank Bldg., Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Feb. 4. Mid-winter meeting in Chicago. Secy., E. B. Burritt, 8 W. 40th St., New York City.

OREGON SOCIETY OF ENGINEERS.
Feb. 7. Annual meeting. Secy., H. M. Morse, Portland, Ore.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 8-9. Mid-winter meeting in New York City. Secy., F. L. Hutchinson, 29 W. 39th St., New York City.

OHIO ENGINEERING SOCIETY.
Feb. 9-11. Annual meeting in Columbus. Secy., John Laylin, Norwalk, Ohio.

MINNESOTA SURVEYORS AND ENGINEERS SOCIETY.
Feb. 10-12. Annual meeting at St. Paul. Secy., Geo. H. Herrold, St. Paul, Minn.

ILLUMINATING ENGINEERING SOCIETY.
Feb. 10-11. Mid-winter convention in New York City. Secy., A. S. Miller, 29 W. 39th St., New York City.

NINTH CHICAGO CEMENT SHOW.
Feb. 12-19. First Infantry Armory and Coliseum. Secy., R. F. Hall, 208 South La Salle St., Chicago, Ill.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 14-15. Annual meeting at New Haven. Secy., J. Frederick Jackson, Chamber of Commerce Bldg., New Haven, Conn.

BUILDING INSPECTORS' CONFERENCE.
Feb. 14-15. In Chicago. Secy., S. J. Williams, Madison, Wis.

AMERICAN CONCRETE INSTITUTE.
Feb. 14-17. Annual convention in Chicago. Secy., John M. Goodell, 1418 Walnut St., Philadelphia, Penn.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 14-17. Annual meeting in New York City. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 15. Annual meeting in Toronto, Can. Secy., L. V. Rorke, Parliament Building, Toronto, Ont.

SECOND NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 15-18. At Chicago. Secy., J. P. Beck, 208 South La Salle St., Chicago, Ill.

IOWA ENGINEERING SOCIETY.
Feb. 16-18. Annual meeting at Des Moines. Secy., J. H. Dunlap, Iowa City, Iowa.

The San Francisco Association of the American Society of Civil Engineers elected H. L. Haehl, president, and Jerome Newman, vice president.

Canadian Society of Civil Engineers—The 30th annual meeting of the society will be held in Montreal, Jan. 25 to 27. The secretary is Prof. C. H. McLeod, 176 Mansfield St., Montreal.

American Society of Engineering Contractors—The annual meeting will be held in the Engineering Societies' Building, New York City, on Jan. 21 at 8 p.m. The banquet will be held on Jan. 22 at 7 p.m. at the Café Boulevard. The Secretary is J. R. Wemlinger, South Ferry Building, New York City.

Building Inspectors' Conference—The conference of building inspectors, whose first meeting was held in New York last May, expects to convene this year in Chicago in connection with the meeting of the American Concrete Institute and the Cement Show, on Feb. 14 and 15. The secretary is Sidney J. Williams, Madison.

The State Highway Commission of Iowa has decided that the highway engineers shall hold their annual meeting Feb. 1 to 3. The meeting will be largely devoted to a study of the road law and standard specifications for the various materials and construction used, and recent methods of construction. All county engineers are expected to attend the sessions. Information concerning the meeting can be obtained from Thomas H. MacDonald, Chief Engineer, Iowa Highway Commission, Ames, Iowa.

The Ohio Water-Works Association will hold its fifth annual meeting on Jan. 26 and 27 at the Chittenden Hotel in Columbus, Ohio. There will be one formal address, which will be given by C. V. Critchfield, expert for the Public Utilities Commission of Ohio. One session will be devoted entirely to a question-box discussion for the solution of knotty problems bearing upon the work of the members. F. C. Jeannot, the secretary, states that one session will be devoted to the question, "How much does it cost to pump a million gallons of water?"

Western Society of Engineers—The officers for 1916 have been elected as follows: President, B. E. Grant, division engineer, Board of Local Improvements, Chicago; vice presidents, C. H. Cartlidge, bridge engineer, Chicago, Burlington & Quincy R.R.; D. W. Roper, Commonwealth Edison Co.; F. H. Newell, professor of civil engineering, University of Illinois; treasurer, C. R. Dart, bridge engineer, Sanitary District of Chicago; trustee, Ernest McCullough. The annual dinner was held Jan. 12, at which Samuel Insull, of the Commonwealth Edison Co., was principal speaker.

American Institute of Consulting Engineers—The annual meeting was held at the Engineers' Club, New York City, on the evening of Jan. 17. The results of the letter ballot for officers were the election of Samuel Whinery as president and Dr. Alex C. Humphreys and F. A. Molitor as members of council. The retiring president, E. L. Corthell, reviewed the work of the institute during the year. Doctor Mathot, of Brussels, president of the International Federation of Institutes of Consulting Engineers, who was present as a guest, described the work of the federation.

American Highway Association—A special meeting of the Board of Directors was held in Washington, D. C., Jan. 12, to consider an invitation from the American Road Builders' Association to join in holding a convention at Pittsburgh on Feb. 22-25. The following resolutions were adopted:

Resolved, that in view of the understanding very definitely reached prior to the Pan-American Road Congress at Oakland, Calif., in September, 1915, that there would be no other national road meeting during the succeeding twelve months, the American Highway Association feels that in good faith to all interested in the good-roads movement it cannot accept the invitation of the American Road Builders' Association to participate in its proposed congress of February-March, 1916.

Resolved further, that this Association expresses its entire sympathy with the plans and purposes of the American Association of State Highway Officials as outlined in its resolution of Dec. 8, 1915, and will lend all its efforts to the successful carrying out of that plan. With that end in view it is the purpose of the American Highway Association to cooperate with the American Association of State Highway officials in its proposed joint congress to be held in December, 1916, or at a later date.

American Concrete Institute—The annual convention, to be held at the Auditorium Hotel, Chicago, Feb. 14 to 17, 1916, has been arranged so as to afford those in attendance the opportunity of visiting the cement show and the sessions of the National Conference on Road Building, Feb. 15 to 18. A preliminary announcement of the program includes the following papers: "Relining the Winston Tunnel, Chicago Great Western R.R.," Harold P. Brown; "Swimming Pools," E. D. Boyer; "Novel Features of Concrete Work on the New York Subway," Robert Ridgway and Ralph E. Goodwin; "Cost Accounting on Concrete Work," Sanford E. Thompson; "Requirements of Building Codes for Columns," P. P. Furber; "Construction of Flat-Slab Floors," details of this paper are in the hands of a special committee, which will announce the author later; "Genesis of Reinforced-Concrete Construction," Prof. W. K. Hatt; "A Further Discussion of the Steel Stresses in Flat-Slab Floors," Prof. H. T. Eddy; "Design of Foundations for Reinforced-Concrete Buildings," Robert W. Boyd; "Tests Showing Continued Deformation Under Constant Load," Prof. A. H. Fuller and Prof. C. C. More; "Forms for Concrete Work," R. A. Sherwin; "Construction of the Large Concrete Viaducts on the Lackawanna R.R.," C. W. Simpson; "Concrete Foundations for Pavements for Heavy Travel," Clifford Richardson; "The Chemistry of Portland Cement," George A. Rankin; "The Design of Plain and Reinforced-Concrete Sewers," W. W. Horner.

New England Water-Works Association—The annual meeting was held at the Hotel Brunswick, Boston, on Jan. 12 and was largely attended. As usual the annual meeting this year consisted of a single business session which followed immediately after the monthly luncheon of the association.

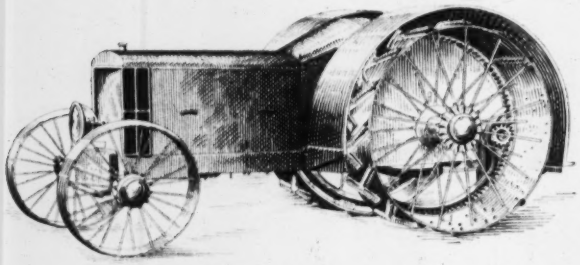
The announcement of the result of the letter ballot for the election of officers showed that William F. Sullivan, engineer and superintendent of water-works, Nashua, N. H., had been elected president and that the secretary, treasurer and editor had been reëlected. The report of the Executive Committee, presented by Leonard Metcalf, president of the association, showed a membership of 961. There was a net membership gain of 114 during the past year, resulting largely from admitting members of the American Water-Works Association without payment of the usual entrance fee. Altogether 92 members and 8 associate members, or 100 in all, took advantage of this privilege. Mr. Metcalf stated for the Executive Committee that none of the standing committees had completed reports during the year, but progress had been made by a number of the committees, including among others the committees on meter rates, cast-iron pipe specifications, standard hydrant specifications, service pipes, leakage and pipe joints.

The Committee on the Brackett Memorial, through Frederic P. Stearns, chairman, reported that it is proposed to have the memorial take the form of a bronze medal to be given annually for the most meritorious paper presented to the association. A few members have already guaranteed enough money to assure the success of the memorial, and it is intended to give the entire membership an opportunity to contribute to the funds soon.

Appliances and Materials

Tractor for Road and Farm Work

The tractor with automobile lines, shown herewith, is of the big-wheel class. Its two large rear wheels are driven by internal gears and pinions, and all its wheels are mounted on roller bearings. It is made in two sizes, developing 28 and 16 hp. at the drawbar, with a pull of 4,500 and 2,200 lb. In the larger machine the driving wheels are 5½ ft. in diameter and 20 in. wide, and the wheelbase is 8½ ft. It carries 35 gal. of gasoline and 10 gal. of water for cooling. The driver sits on a mowing-



TRACTOR FOR ROAD WORK

machine seat between the large wheels and back of the rear axle. The weight in working order, with tanks filled, is 8,700 lb. for the larger and 5,200 lb. for the smaller machine. A belt pulley is provided for operating farm machinery, crushers, etc. These tractors have been used in roadwork, hauling wagons of crushed stone and operating road drags and graders. One hauled six loaded (5-ton) wagons on a 20-mi. run with grades of over 8%, and made the round trip in 6½ hr. with a consumption of 25 gal. of gasoline and 1½ gal. of oil. The machine is known as the "Little Giant" tractor and is built by the Mayer Brothers Co., of Mankato, Minn.

* * *

The Ford as a Fire Truck

A low-priced fire truck for small towns is being put out by the Hallock Engineering Co., of Cleveland. Standard chemical-extinguisher equipment, ladders, etc., are mounted on a Ford automobile chassis.

There is one 35-gal. copper chemical tank, with all the usual fittings and accessories, 200 ft. of four-ply red-rubber chemical hose in 50-ft. sections, a hose basket, two 3-gal. copper hand-extinguishers, an extension ladder in 9-ft. sections, an extra acid tank and soda canister, an 8-ft. pike pole, a 6-lb. fire ax, an 8-lb. crowbar, two oil lanterns, electric head and tail lights, a 9-in. gas searchlight with a 30-hr. tank, and complete tool equipment for car and fire equipment. The front seat carries two men and the rear step one man. The truck is painted in department red.

A 530-lb. water-hose trailer wagon is also marketed by the same concern for use with the truck described. The trailer has short-turn gear so that it follows the truck track. It has automobile wheels. The body is 6 ft. long by 40 in. wide and can carry 1,000 lb., in men or equipment. The trailer coupling is disconnected by a driver's pedal on the rear of the truck.

* * *

New Detachable-Point Pick

The "Harringford" detachable-point pick shown in the accompanying sketch is being marketed jointly by Alfred Windsor & Son, 156 State St., Boston, and H. B. Goodrich & Co., 27 Cedar St., New York City. A two-part eye is formed by malleable-iron castings bolted together. The bolt holes

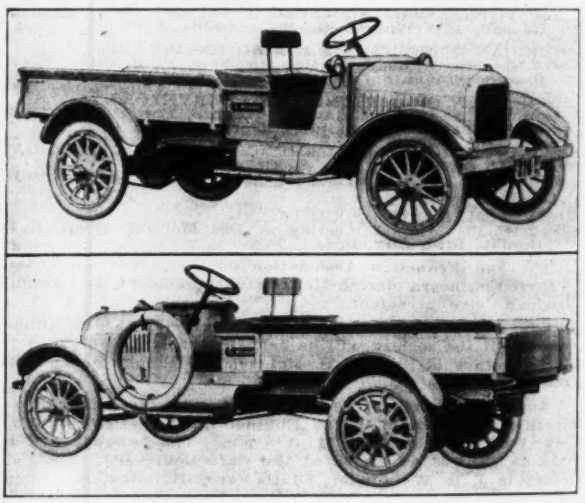
HARRINGFORD DETACHABLE-POINT PICK

are threaded on the nut side and the nut serves to lock the bolt; there is also a spring-lock washer under the nut. It is reported that this scheme effectively holds the pick parts together. The points are ordinarily of tool steel (65 carbon or better) and can be tempered. Manganese-steel points are to be supplied for railway track tamping. The shank of the points is tapered to fit tapered recesses in the eye so that a large friction bearing is secured. The bolt hole in the point is enlarged. This pick (contractor's No. 9) sells for $10.27 per doz. ready for handle f.o.b. Boston; the points are $5.13 per doz. pair.

* * *

A 1,250-Lb. Motor Truck

A new motor truck, light but strongly built, of 1,250-lb. capacity, was recently placed on the market by the Kentucky Wagon Manufacturing Co., of Louisville, Ky. The main frame of the truck is made of high-carbon rolled-steel channels instead of pressed-steel shapes, and all brackets and fastenings on the main frame are made to the web of the channels, no perforations being made in the flanges. The front cross-member of the main frame serves as a bumper and extends on each side to protect the wheels. The radiator is mounted on springs, thus relieving it from shock. As it is set well back from the front cross-member, it is protected from possible collision. An extension on the brake pedal, which engages the heel of the driver's shoe, permits him to operate the accelerator without removing his foot from the brake pedal. An abstract of the specifications follows: Load-



"OLD HICKORY TRUCK," 1,250 LB. CAPACITY

ing space, 6½x3½ ft., with drop-end tailboard; wheelbase, 110 in.; three speeds forward and one reverse; motor with four 3¼x5-in. cylinders; "Dyneto" electric starter and "Connecticut" ignition; three-point suspension on the motor and three-point suspension for the rear axle case through two full elliptic springs at the rear and the torque-tube yoke secured to the side channels; straight-line drive through one universal when under full load; brake linkage under spring tension to eliminate rattling. The list price is $825 f.o.b. Louisville.

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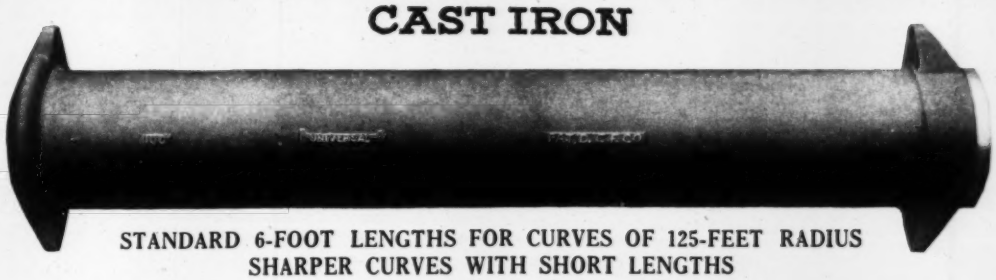
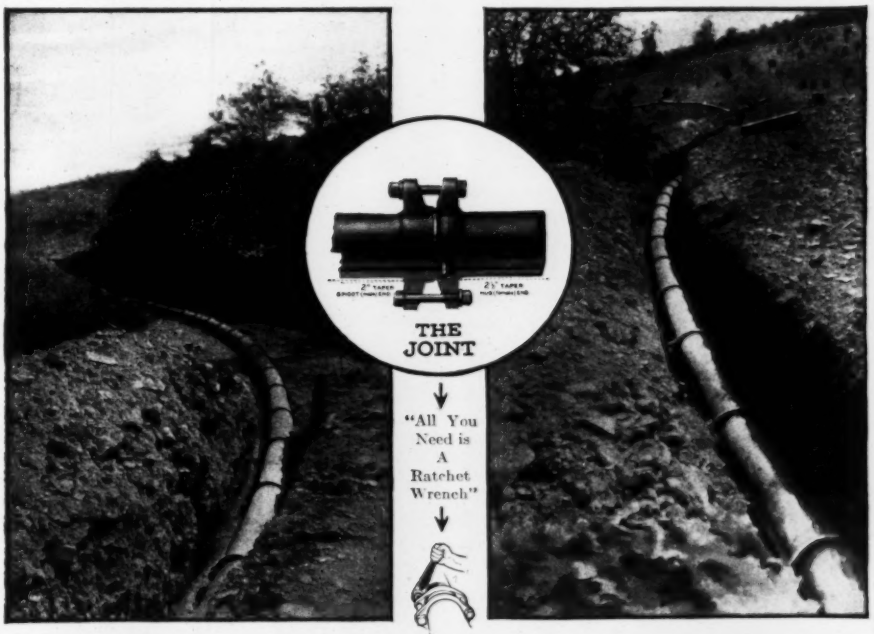


STANDARD 6-FOOT LENGTHS FOR CURVES OF 125-FEET RADIUS
SHARPER CURVES WITH SHORT LENGTHS



12-Inch UNIVERSAL PIPE Lines at Juniata, Penna.

Harvey Linton, C. E., Altoona, Penna., Engineer for Juniata Water Commission

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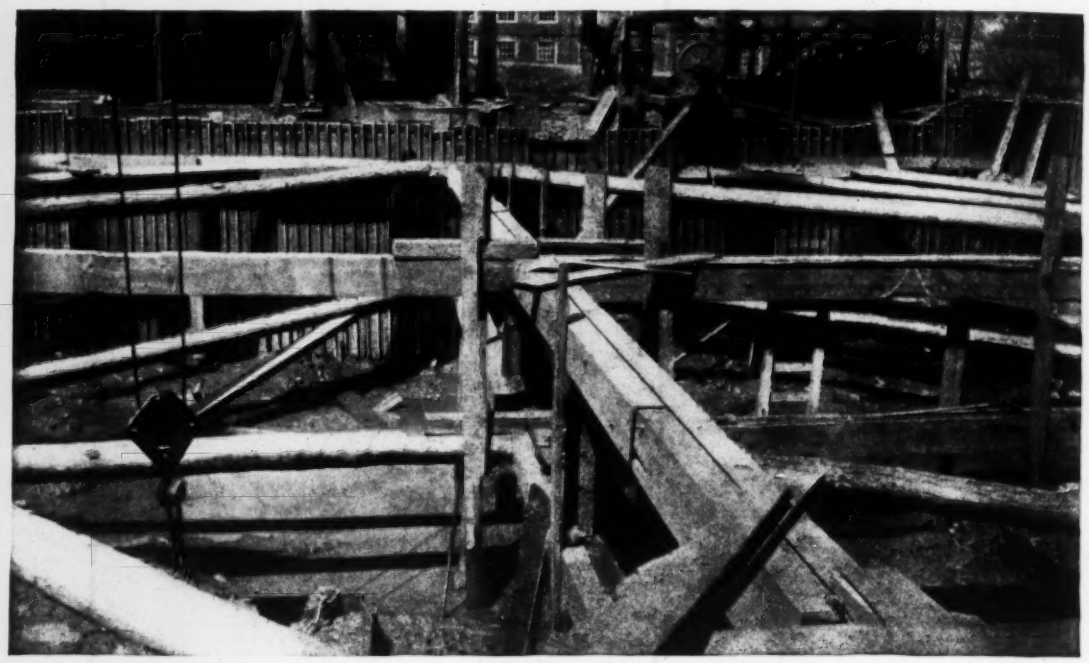

7-In. Lackawanna Steel Sheet Piling that Drove at 1/4 the Cost of Driving Wooden Sheeting, and Was Used Three Times in Succession.

This is the interior of a temporary cofferdam driven by A. J. Twiggs & Son, Contractors, Augusta, Ga. The following comment by that firm gives some performance records that you can profit from if you have similar work:

"This Lackawanna Steel Sheet Piling was driven after five feet into shale rock, and after the dam was pumped the rock for the last two feet was found to be hard to pick, and had to be drilled and shot. The Lackawanna Steel Piles were pulled and redriven three times at this location, and were perfectly good when pulled the last time.

"We have recently driven this same piling in permanent work at Savannah, Ga., spliced out and made into 32-foot lengths. We have found that by using this sheet piling we save considerable bracing, and effect a very large reduction in labor cost in driving, as compared with wooden piles. In each instance that we have used the steel piling, wood was first tried, and on account of obstructions was abandoned and the steel substituted. We have driven this piling through 12"x12" timbers and find that with the extreme flexibility of the joints, obstructions can be passed by deflecting the piling line.

"Each time that we used this steel piling the construction necessitated watertightness. We made the piling sections watertight by closing the space in the joints with a cotton rope just large enough to fit in. This swelled and made the joint tight, yet allowed the piling to be pulled with ease. In driving we used an Ingersoll-Rand steam hammer, weighing about 1200 pounds.

"From my experience we can drive this piling at about one-quarter the cost of wood. We excavated within six inches of the bottom of the sheet piles, leaving a shoulder of about four feet next to the piles. We had a head of twelve feet of water."

We can show you countless instances where Lackawanna Steel Sheet Piling succeeded after wooden sheeting had failed—and our Steel Sheet Piling Engineers are always ready to help make Lackawanna Sheet Piling succeed.

Those actively engaged in construction work can have a copy of our book—"Lackawanna Steel Sheet Piling" free on application.

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Making the Earthwork Approach to Columbia River Bridge

By E. E. Howard*

The Columbia River Interstate bridge, now under construction for Multnomah County, Oregon, and Clarke County, Washington (see *Engineering News*, June 24, 1915, p. 1218), comprises a bridge over the main channel of the Columbia River, which is 3,500 ft. wide; a bridge over a subsidiary channel known as Oregon Slough, about 1,000 ft. wide, separated from the main river by Hayden Island, over which an embankment is to be constructed; and an approach from the Oregon Slough to the city limits of Portland, Ore., made up of a continuous embankment, with the exception of a bridge 300 ft. long over the Columbia Slough—an overflow channel about a quarter-mile from the city limits. The total distance from the south side of the Oregon Slough to Columbia Boulevard, which marks the end of the bridge approach and is practically at the city limits of Portland, is 10,800 ft. The Columbia River bottom, or alluvial valley, extends at this point about a quarter-mile within the city limits, so that the entire portion of the approach as mentioned is built upon this alluvial bottom.

Over this two miles the natural ground surface has an average elevation of 12 to 15 ft. above low water, and the entire area is cut up with various small sloughs and water courses, among which are interspersed various shallow lakes, or backwater ponds. The normal high water, which occurs every two or three years, reaches an elevation of about 25 ft.; and once a flood reached an elevation of 33 ft.

While the area of the valley of the Columbia River inundated by such high water as occasionally occurs is large, the actual discharge over the inundated lands, from the meager records available, is believed to be small.

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FIG. 1. BULKHEAD BOARDS FOR RETAINING HYDRAULIC FILL FOR EMBANKMENT APPROACH TO COLUMBIA RIVER INTERSTATE BRIDGE

The embankment of the approach therefore is made continuous from the south side of the Oregon Slough to the Columbia Boulevard, with the exception of the channel for the Columbia Slough. The top of the embankment is at an elevation of 35 ft. above low water, increased somewhat at the ends of the bridge, so that it will be 2 ft. higher than the extreme flood level. This embankment has a top width of 42 ft. and side slopes 2 horizontal to 1 vertical. The upstream side of the embankment is to be protected along its toe by a concrete slab, and the remaining portions of the slopes are to be covered with grass and shrubs to prevent erosion (Fig. 2). The placing of the material in the embankments included in this described portion of the approach has just been completed and has certain features of interest mainly on account of the efficient methods of handling the work.

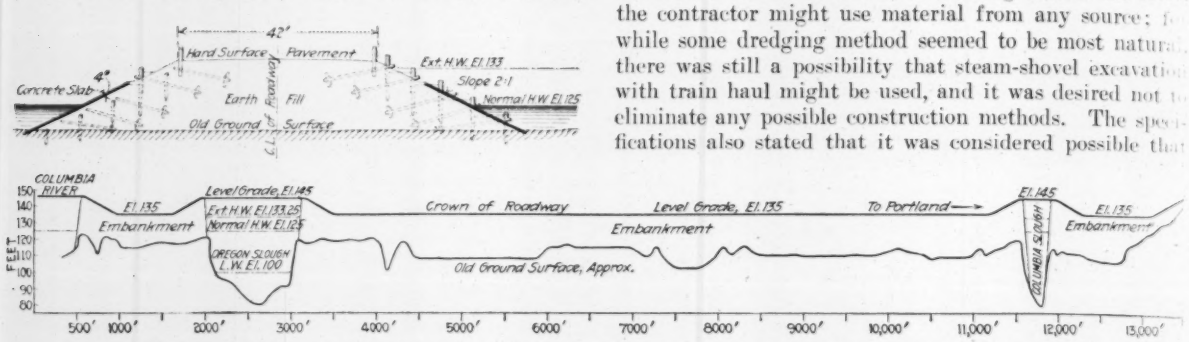


FIG. 2. DETAILS OF EMBANKMENT FOR SLOUGH CROSSINGS OF COLUMBIA RIVER BRIDGE

The specifications for the embankment provided that the material should be "sand, gravel, clay, or loam, or other earthy material free from foreign substances," but stated that while it was expected that most of the embankment would be made of sand dredged from the river, the contractor might use material from any source; for while some dredging method seemed to be most natural, there was still a possibility that steam-shovel excavation with train haul might be used, and it was desired not to eliminate any possible construction methods. The specifications also stated that it was considered possible that the land would subside under the embankment, and bidders were requested to investigate construction works in the vicinity. Bids were asked for a unit price per cubic yard of volume included between the existing ground surface and the required top elevation and required net side slopes of the embankments, with no payment to be made for extra material necessary on account of shrinkage or of subsidence of land, should such subsidence occur,

Bids were received in February, 1915, and the prices bid varied from 13.24c. to 27c. per cu.yd. The contract

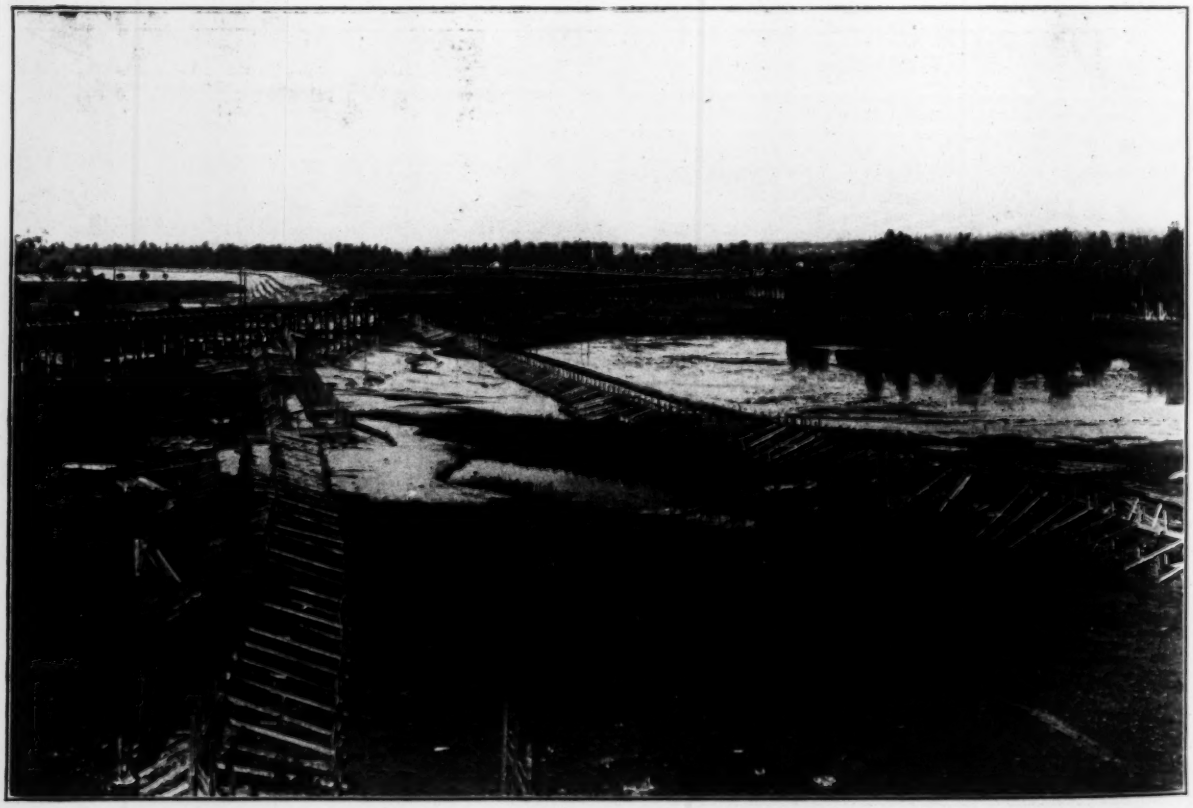


FIG. 3. LOOKING OVER CONSTRUCTION OF APPROACH EMBANKMENT TOWARD VANCOUVER, WASH.
The trestle is the present country road leading to a ferry near the new bridge location

was let to the Tacoma Dredging Co., of Tacoma, Wash., at its bid of 13.24c. per cu.yd. of the net volume in place as described. This company moved its dredge to the site, installed pipes and pumped in the first sand on June 9. By Nov. 20 all of the embankment south of Oregon Slough had been placed—a total net volume of 821,000 cu.yd. The placing of this material occupied 160 days, or an average of about 5,000 yd. a day. The material remaining in the embankment is a medium-fine sand, sharp and clean. Some of it has been considered sufficiently satisfactory for use in concrete. There remain at the present time the dressing down of the slopes of the embankment, the construction of the concrete-slab protection, the seeding of the embankments and the construction of the pavement to complete this portion of the approach.

Method of Making Excavation

The material was excavated from the Oregon Slough by means of a suction dredge of usual type, with a cutting head, and was transported to place by being pumped through a line of pipe 24 in. in diameter. The operation was by electric power from the high-voltage lines of the Portland Railway Light and Power Co. The main pump on the dredge was operated by two 500-hp. motors connected to the pump by rope drives. The pump was of capacity to give a discharge through the 24-in. pipe at a velocity of 12 to 15 ft. per sec. Operation continued 24 hr. per day during the time specified, and the dredge was actually running about 14 hr. per day. For periods of a few hours at a time the dredge pumped as much as 1,000 cu.yd. per hr. There was of course a very considerable runoff of sand from the embankment, as well as a certain amount of fine material which flowed away with the waste water, and it is estimated that about 250,000 cu.yd. more than the above net amount was transported. The discharge-pipe line was extended to a length of about 4,000 ft., working from the dredge alone. For the greater distances a booster pump was installed in the line to give additional impetus. This pump was operated by a single 1,000-hp. motor operating with considerable overload. The dredge and booster pump together transported through a maximum length of 9,000 ft. of pipe. Such long-distance dredging into an embankment so comparatively narrow and high is believed to mark a record for work of this character. The pipe was of the ordinary riveted variety with slip joints made of 7-gage material on the pontoons and of 10-gage material elsewhere. It was moved about by teams and wagons.

Timber Bulkheads for Earth Backing

The embankment was formed by the use of timber bulkheads (Figs. 1 and 2). These were built of 6x8-in. posts, about 10-ft. centers, supporting 2x12-in. sheathing, surfaced both edges. The sides of the embankment were built up by these means in steps 8 ft. wide and 4 ft. high. The first bulkheads were placed upon the natural ground surface by driving in the 6x8-in. posts with a hand maul and setting the lower plank into a small trench so that the bulkhead sheathing extended perhaps 8 to 12 in. below the ordinary ground surface. When the sand had been filled in about the top of such first bulkheads, posts for succeeding bulkheads were set in place and the lower plank placed so that it extended about 12 in. below the top of the first bulkhead below. These posts were tied back into the embankment by 2x6-in. ties spiked on near the top of each post and extending back to a short post, in front of which were placed a few pieces of lagging to offer additional resistance. The pipe was laid to discharge into the middle of the embankment so marked and was carried forward from the river, bringing the embankment up to the final grade and working away from the dredge. A framework of baffle-boards was placed under the discharging end of the pipe, causing the water to spread out and spill over the ground below and run forward, distributing the different sizes of material as the velocity decreased (Fig. 4). At some convenient low point there was provided an outflow down the side of the embankment, for which the steps of the embankment were paved with plank to prevent wash.

The methods of constructing the bulkheads and of the discharge arrangement are clearly shown by the accompanying photographs. After sections of the finished embankments became thoroughly drained as the work proceeded, the posts of the bulkheads were cut away and the planks removed and carried forward for repeated use.

FIG. 4. OUTFLOW PIPE OF THE HYDRAULIC DREDGE

Parts of the posts and of the 2x6-in. ties therefore remain in the embankment. The finishing of the slopes was done by hand with shovels, and the successive steps were so located that the upper corner of each step filled into the lower corner of the step below, to provide the proper slope. The actual pumping and transportation of the sand in the hands of these contractors were the simplest parts of the work, and they found it economical to permit a very considerable wastage of material where a reasonable amount of such wastage saved in the construction of bulkheads.

Earth Slip Overthrows Masonry Pier

The subsidence of the land has been comparatively small, probably averaging less than 1 ft. over most of the area. In three locations there was considerable subsidence, of which two instances meant merely the reconstruction of some bulkheads and the placing of additional material, but the third instance, combined with other causes, affected the partly completed substructure.

The Columbia Slough is a slack-water channel meandering through the bottom about parallel to the main river and about a mile to a mile and a half away from it. While it seems to maintain some average depth, the water flows through it with equal facility in either direction, depending upon the rise or fall of the river. Its width

and cross-section vary considerably, and in the exigencies of locating the approach it happened that the crossing came at a place where the slough is much wider than it is a mile or two farther downstream. The slough is crossed by four 76-ft. deck-girder spans which rest upon concrete pedestal piers supported on piles. Hard cemented gravel conglomerate is encountered at an elevation 60 to 80 ft. below low water, but overlying this hard material is the bed of the slough—a rather soft, oozy clay through which foundation piles were readily driven. The shore ends of the end spans rest upon buried piers in front of which the embankments are carried down on ½ to 1 slopes

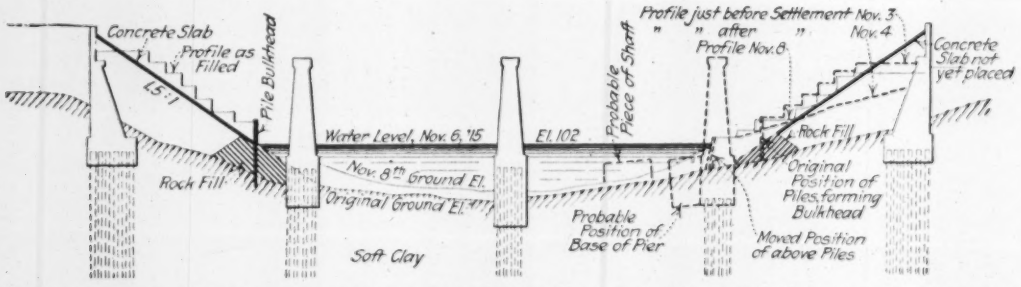


FIG. 5. PROFILE OF COLUMBIA SLOUGH, SHOWING AT RIGHT THE PIER PUSHED OUT OF PLACE

toward the channel. Such construction, involving somewhat additional length of steel, is much more economical than the use of abutments to support embankments 35 ft. high, 180 ft. wide on the bottom, which would have been exceedingly expensive to construct in any manner which would provide the necessary resistance to horizontal thrust.

The plans provided for the construction of loose rock-fills of stones weighing 100 lb. to 500 lb. per piece, around the toes of the slopes of the embankments in front of the buried piers. The rock-fills were to be brought up to elevation 5 ft. above low water, with a top width of 2 ft. and slopes of 1½ to 1 on each side; and the specifications provided that these rock-fills should be made complete before the earth embankments above them were placed, which in turn were to be protected over their entire surfaces by reinforced-concrete slab aprons 4 in. thick.

The masonry pedestals in the slough supporting the girders consist of bases about 12 ft. square supporting cylindrical shafts 5 ft. 6 in. in diameter at the top and about 8 ft. in diameter at the bottom, which is 2 ft. below low water. The girders are spaced transversely 23-ft. centers. Each pair of pedestals is connected at the top by horizontal and vertical diaphragms of reinforced concrete. The bases of the side piers in the channel are 18 ft. high, sunk into the river bed from 8 to 12 ft. The foundation piles supporting and forming a part of the base were driven to the conglomerate bedrock.

Temporary Timber Bulkheads Used

Throughout the past summer the water in the Columbia River was exceedingly low and the Columbia Slough correspondingly low. The only practicable method of delivering the rock of the rock-fills seemed to be by barge, and it was found very difficult to bring rock barges through the shallow and tortuous channel from its outlet to the river some three or four miles distant. Therefore in order to continue with the sand-filling without delay when the slough was reached, vertical timber bulkheads were used to support these forward slopes during the filling in of the sand and until such time as with a higher stage of water the rock could be delivered, which was then to be deposited in front of the bulkheads as planned. These lower bulkheads were constructed by driving piles about 40 ft. long 8 ft. apart and tying the upper ends with cables to deadmen well back on the shore. They were then planked behind from the bed of the slough to their tops, and so afforded vertical walls from 12 to 18 ft. high. Prior to this time the piers had all been built; only pier 27 had not been entirely completed. The embankment in front of the buried pier on the north side of the slough was placed as planned, and only a slight subsidence or movement of the supporting ground was noticed; the rock-fill in front of the bulkhead has now been placed substantially as planned.

The filling in front of the south buried pier was about completed, and behind it lacked 10 ft. of full height when about midnight of Nov. 3, 1915, a settlement and slippage forward of the material in front of the buried pier occurred, which carried the bulkhead down against the bases of pier 27; as these had very small lateral resistance, they were pushed toward the channel of the slough and the partly finished shaft upon them thrown off.

The slip began with the sliding away of a part of the natural bank just downstream from the outer edge of the toe of the embankment, and about two-thirds of the bulkhead supporting the fill in front of the pier moved forward. The material exposed by the slip of the embankment was soft clay through which water was running from the drainage of the material pumped into the embankment. The dredge was discharging its 100 cu.yd. of water per min. on the fill just back of the buried pier, and some of this water was seeping through the original bank back into the slough. Along the slough 4 or 5 ft. below the top of its bank there were numerous little streams and leakages of water from this drainage coming out of the bank—a condition, combined with the low water, more severe than can ever again occur. The buried pier itself was found to be in correct position and showed no movement whatsoever, the entire movement being of the material in front of this pier, or abutment. The surface indications were that the material in front of the abutment settled vertically and caused a horizontal movement of the slough bed which might have been to any depth; that is, the weight of the embankment placed caused the soft slough bed to squeeze out. Upon pulling the piles in the bulkhead, however, it was found that they were broken off at, or a short distance below, the original slough bed, which would indicate a sliding forward of the filled material on the slippery slough-bed surface.

The embankment has since been replaced in front of the buried pier as originally planned, and the entire

embankment behind it completed. Pier 27, which was displaced, is being repaired by the driving of additional foundation piles and the placing of additional concrete for the base. New shafts of course will have to be built.

Earth Settlement

The other most serious settlement in the construction of the embankment occurred adjacent to the existing county-roadway trestle, which is shown in Fig. 3. Over some distance the ground subsided 3 to 4 ft. and carried down with it a part of the timber trestle. This involved the displacement and partial destruction of some of the bulkheads, which had to be rebuilt, and did some damage to the trestle, but the total expense involved was not very great. It is interesting to observe that the ground which showed the most subsidence is fully a mile back of the river bank, which would lead to the conclusion that probably a main channel of the Columbia River originally followed the foothills along the southern edge, instead of as now along the high ground at the northern edge, of its valley, on which Vancouver, Wash., is situated.

The construction of the embankment has been carried out by the Tacoma Dredging Co., of Tacoma, Wash., of which Edward Simpson, who gave his close personal attention to the work, is president. The work was particularly in charge of Mr. Strong and Mr. Richie, engineers of the company. The work has gone forward methodically and in good order, the operations of construction at the end being practically the same as when starting, indicating the well-matured plans of the contractors. Harrington, Howard & Ash, Consulting Engineers, Kansas City, Mo., are in charge of the bridge construction.

Oklahoma Conserves State's Natural Gas

In March, 1915, the Oklahoma legislature declared the wasteful production of natural gas in Oklahoma to be unlawful and authorized the State Corporation Commission to make regulations for the prevention of waste and the protection of strata carrying natural gas, fresh water and oil. After an exhaustive inquiry (the proceedings of which are reprinted in "Public Utility Reports," 1915 E, pp. 994-1063) the commission found that many of the state fields had been completely exhausted while the entire remainder of all gas fields so far as discovered and opened up had been greatly depleted, and that this action had been caused more by waste than by utilization. Fully 80% of the gas opened up had gone to waste, and the present daily loss was conservatively set at 200 million cubic feet. The commission reported that no real effort had ever been made by oil operators for the conservation of natural-gas resources, that it was of the opinion that a quantity of less than 2,000,000 cu.ft. per day unrestricted flow was a "commercial quantity" and that all gas strata should be protected. Twenty-eight rules were formulated for the protection of the supply.

Wasteful production is prohibited. Waste is defined as (a) escape into the open air, (b) intentional drowning of a gas stratum with water, (c) underground waste, (d) permitting burning, and (e) general wasteful utilization. Whenever natural gas is encountered in commercial quantities in any well drilled for oil or gas, such gas must be confined to its original stratum until it can be utilized without waste. Any stratum showing well-defined gas sand and producing gas is considered capable of producing in commercial quantities and is to be protected.

Where production from any common source of supply is in excess of the market demand, then any concern having the right to drill into and produce gas may draw therefrom only such proportion of the natural flow as may be marketed without waste. Concerns purchasing and selling natural gas are held to be common purchasers, and are required to buy all that may be offered for sale within reasonable reach of trunk lines. One rule prevents discrimination between purchase or sale of like grades and pressures of gas.

It is ordered that all gas sold shall be metered. The Corporation Commission will prescribe rules and regulations for determining the natural flow from a well or group and may regulate the taking of gas in order to prevent waste and discrimination. Any concern purchasing or transporting natural gas must file an acceptance of the law.

Before commencing to drill a well an operator must provide a sump for pumpings from clay and soft-shale strata to make mud fluid. All dry or abandoned wells must be plugged under inspection of the state mine inspector and be filled with mud fluid. Where it is not fully determined that high pressure will not exist, a control casing head must be used. Where an operator drills through one stratum to lower strata, the upper ones must be sealed to prevent waste. Where oil and gas are found in the same stratum and it is impossible to separate one from the other, the operator may be required to install an improved separating device.

The future use of vacuum pumps on gas- or oil-bearing strata is prohibited without the permission of the commission. No outside casing from any oil or gas well in an exhausted field should be pulled without first flooding the well with mud fluid. To avoid existing underground waste, pollution or infiltration, a concern must, on the order of the commission, raise any strings of casing and reseat them in mud.

A log of the drilling operations for any well must be signed, sworn to, and furnished the commission. Complete records of plugging operations must be similarly filed. All oil and gas concerns between the first and tenth of each month must gage the volume and rock pressure of all wells producing natural gas and report to the commission. When the gas from any well is being used, the production shall be restrained to 25% of the potential capacity shown by the last monthly gaging.

The Altoona Shops of the Pennsylvania R.R. are the largest railway shops in the world, and represent an investment by the railroad company of about $20,000,000. Their annual output in normal times in new cars and locomotives built and in repair work done is about $31,000,000. The site for the shops was chosen by the officials of the Pennsylvania R.R. in 1849, five years before the company opened its all-rail line between Philadelphia and Pittsburgh. The city of Altoona has grown up with the shops as its chief industry and has now over 50,000 population. The total floor space in the Altoona shops is over 2,500,000 sq.ft. The number of men employed is 12,000 to 14,000. The locomotive shops turn out new locomotives at the rate of 200 to 250 per annum and make general repairs to about 1,800 locomotives. In the freight-car shops, about 130,000 freight cars per annum are repaired, and new steel box cars are turned out at the rate of one an hour. In the passenger-coach department new steel cars are turned out at the rate of about 300 per annum and about 2,500 old passenger cars are repaired.

Old and New Water Tanks at Princeton, N. J.

By R. W. Becker*

SYNOPSIS—Striking changes in elevated-tank design, particularly as regards the relation between diameter and height, the shape and support of bottoms and the character of the columns, occurred between 1883 and 1915. A new tank and tower are described.

In 1883 the firm of Tippett & Wood, of Phillipsburg, N. J., fabricated and erected an elevated water tank at Princeton, N. J., for the Princeton Water Co. The capacity of the tank (Fig. 1) was 141,000 gal. The growth of the town since has made it inadequate and it was replaced by a 537,000-gal. tank, built by the same firm early in 1915 (Fig. 2).

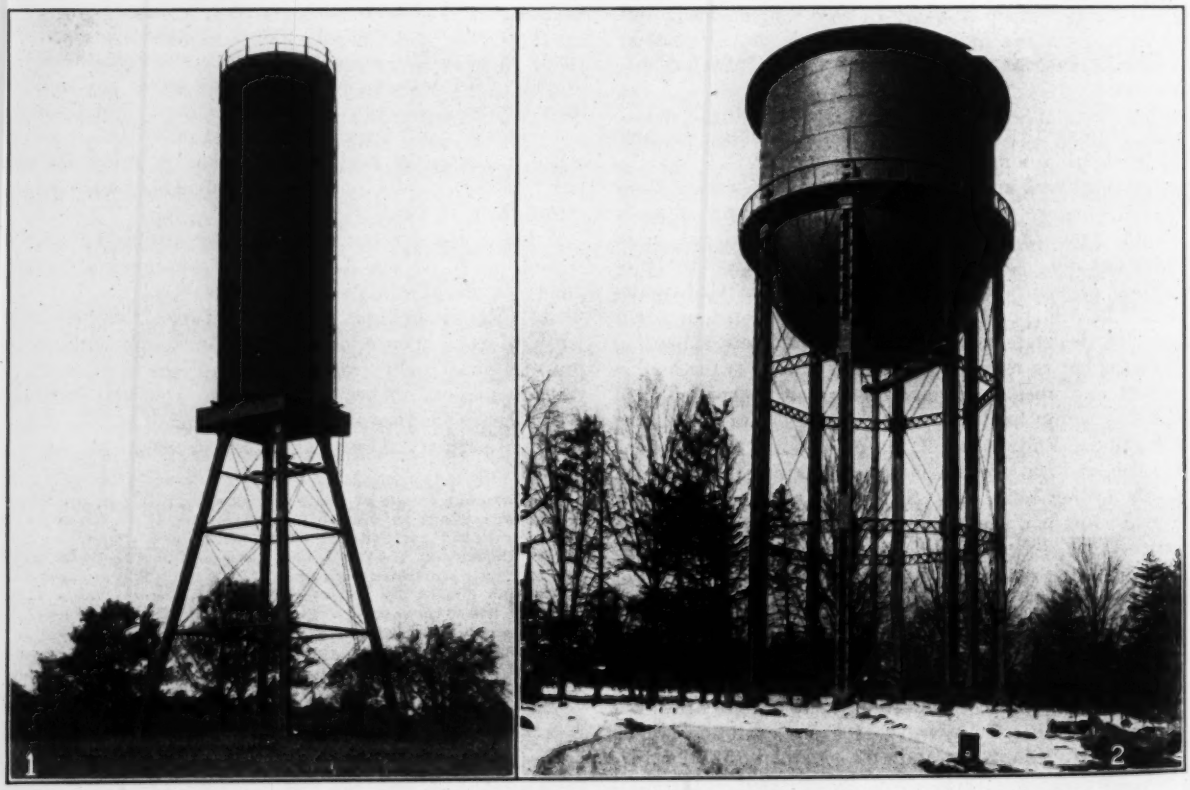
A comparison of the two views shows the great advance made in this class of work. The early designs of tanks and standpipes usually were slender. Modern elevated tanks have diameters equal to or greater than their heights. The supporting towers are directly riveted to the tanks, which are capable of distributing the loads to the columns as well as of acting as containers. The columns of the new tower were therefore built facing radially, while it will be noted that the old tower was built with channel columns facing parallel with the beams just as they would be in a bridge.

*Chief Engineer, Tippett & Wood, Phillipsburg, N. J.

The consulting engineer for the old tower was the well-known bridge engineer Theodore Cooper. In those days ball bottoms were unknown, and it was considered the best practice to place the flat-bottom steel tanks on wooden joists which were supported by a grillage of steel beams. In this case 6x6-in oak timbers, creosoted, were laid only an inch or two apart between the tank and the beams. The latter consisted of two main radial girders 48 in. deep, extending diagonally across the top of the tower and cantilevering over the columns. These supported 42-in. built-up girders on their outer ends so as to form a square, while four 15-in. beams formed an inner square.

All the material in the old tower and tank was iron. The tank, which was 20 ft. in diameter and 60 ft. high, was made of ⅜-in. plates in the bottom and lower rings and $\frac{5}{16}$-in. and ¼-in. plates in the remaining part. The columns consisted of two laced 15-in. channels, weighing 167 lb. per ft. for each channel. The struts consisted of two laced 6-in. channels, weighing 22½ lb. each. The rods were of 1¼-in. round iron.

Recent inspection of the old materials showed that the tower was exceptionally well preserved. Rust had not



FIGS. 1 AND 2. OLD AND NEW TANKS FOR THE WATER-WORKS OF PRINCETON, N. J.
Fig. 1—Erected in 1883. Fig. 2—Built in 1915

caused sufficient deterioration in the tank plates to be perceptible by calibration. The tank received two coats of paint when it was erected and had been painted once every 3 to 4 years since. It had always been filled with water. The only repair required was the replacing of the oak timbers under the tank by 6-in. steel I-beams, 5 yr. ago. The wood was decaying rapidly and appeared unsafe to carry the load much longer after 25 yr. of use.

The old tank and tower were torn down carefully, so as not to injure the plates, by cutting off and backing out the rivets. Each piece as it was cut off was carefully lowered to the ground. As the tank was in such good condition, it was reërected on a concrete foundation at Lawrenceville, N. J., where it is now in service. The tower was reërected at New Brunswick, N. J., where it is supporting a wooden tank of 100,000 gal. capacity. The cost to Tippett & Wood of taking down the old tank and tower was $1,000.

The new tank is 45 ft. in diameter, 30 ft. high from the top to the beginning of the curved bottom, and 58½ ft. high overall. The steel tower supporting the tank is 87½ ft. high from the column foundations to the balcony. The distance from the base of the columns to the peak of the roof is 133 ft.; and from the ground to the top of the finial about 135 ft.

The tower for the new tank (Figs. 2 and 3) consists of eight columns with two sets of struts dividing the tower into three panels, the height of which from the bottom upward is 31, 30 and 28½ ft. respectively. The columns have a uniform section throughout, designed for an allowable unit stress of 12,500 lb. per sq.in. They are built up of a 26x⅝-in. cover plate riveted to the two 6x6x⅝-in. inner angles. The web plates are 18x½ in. The two outside angles, 6x4x⅝ in., are laced by 3x2½x$\frac{5}{16}$-in. angle bars. Where the tank is connected to the columns the latter are reinforced, as shown in Fig. 3. Two additional 6x6x⅝-in. angles are used with two additional 16½x½-in. web plates and filler bars. The struts consist of two pairs of 4x3⅜-in. angles laced by 2½x2½x$\frac{5}{16}$-in. angles, so that they are 2 ft. high. They are connected to the posts by ½-in. wing plates riveted to the web plates immediately under the slide splice angles.

All brace rods are made adjustable in length by turnbuckles. The rods are 1¾ in. in the lowest panels and 1⅝ in. in all other panels. After the loop ends and turnbuckle stub ends were welded to the rods, they were annealed their full length. At the top of the tower, where the latter connects to the tank, is a horizontal girder 3½ ft. wide, which also serves as a balcony. This is attached to the posts by means of heavy plate brackets and is held in a horizontal position by means of three intermediate plate brackets to the tank. The inside flange

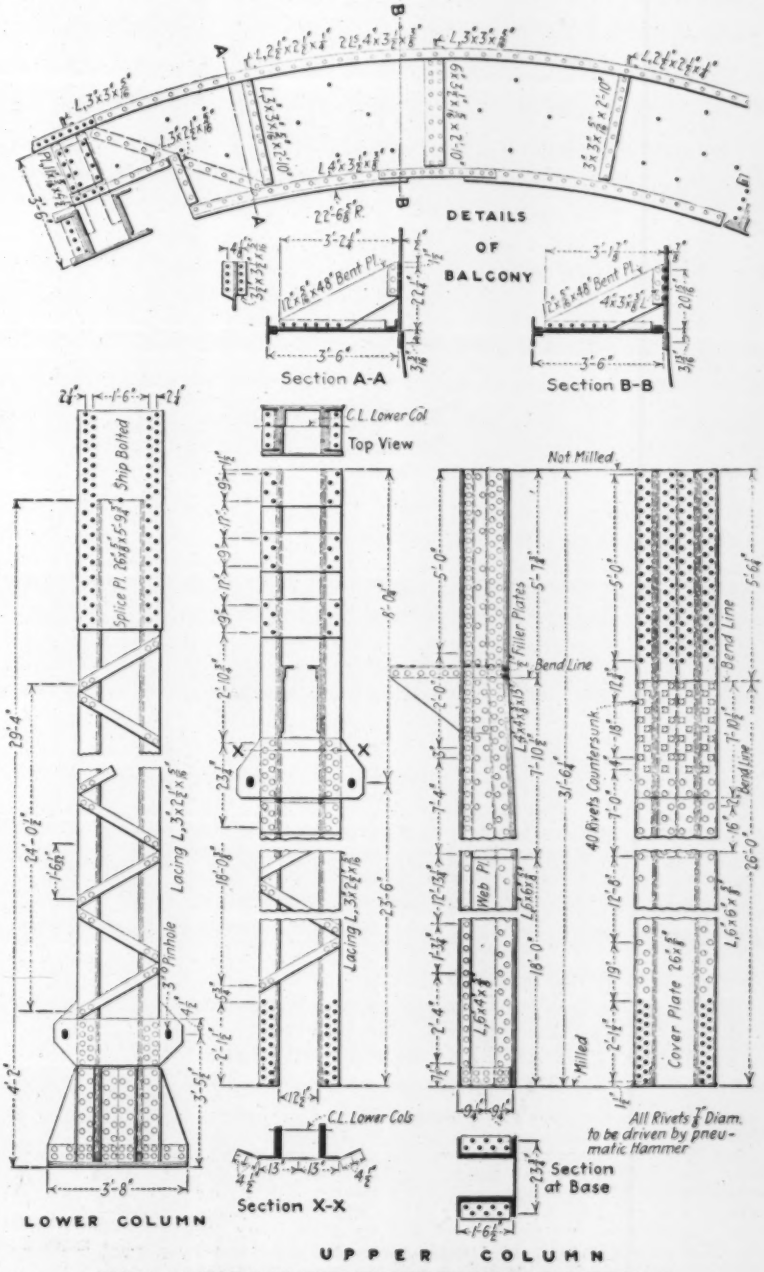


FIG. 3. DETAILS OF NEW WATER TANK, PRINCETON, N. J.

of the girder consists of one 4x3½x⅜-in. angle riveted above the connection of the tank bottom to the cylinder. The outer flange consists of two 4x3½x⅜-in. angles. The $\frac{5}{16}$-in. web plate is stiffened by a 3x3x$\frac{5}{16}$-in. angle at each bracket and is provided with drain holes.

The tank is designed for an allowable unit stress of 14,000 lb. per sq.in. All plates in the tank are of open-hearth flange steel. There are five 6-ft. rings. The first is of ⅝-in. plates with triple-riveted butt seams; the second of ½-in. plates with triple-riveted lap seams; the